# Formalisation of the Requirements Management Process in the Aerospace Industry

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**Abstract:** This paper presents the Requirements Management Process developed for the aerospace industry. This process is extremely relevant to the Product Development Process and can be considered its "backbone", due to the guidance it offers for the development of new products. The main activities of this process include market and customers' research, the understanding of the collected needs, its deployment into product requirements and posterior prioritisation. It is also imperative to monitor the requirements throughout the entire product development process, in order to guarantee that the final product fulfils the customer needs. The development of the requirements management process was initiated with a survey of best practices in the academic realm and at other companies. From this initial analysis, participative interviews with experts inside a case study company were performed to expand the understanding of internal requirements and processes. Once all this information was gathered, a customized process was shaped to the specific particularities of the aerospace industry and has been implemented in every new product development of the selected case study company. The most significant results obtained so far are the following: the existence of explicit documentation of customer requirements; the early definition of requirements' ownership; a single database which avoids redundant information and increases its reliability and finally, the requirements traceability.

**Key Words:** Requirements Management Process, Aerospace Industry, Product Development Process.

## 1. Introduction

Continuous innovation is the key factor for a company to stay in an outstanding position in the market where new technologies spring up daily and product obsolescence is a constant threat. The innovation must, however, fit the market needs and drive a successful product delivery that meets the requirements and needs of its customers.

It can be observed as a general rule, that companies, which are technological based, have pursued differentiation through their own products, i.e., new technologies were developed and incorporated in their products. The companies were certain that this practice was useful for the customers as they experienced growth in market share, as a consequence. Presently this scenario no longer holds: new and more aggressive competitors came in to. No other alternative was left for the companies rather than to seek product differentiation through customers' needs fulfilment. Accordingly, the companies seek to better understand what the customers needs and only then, a specific and customised solution is derived.

There are numbers of proven methods and techniques in the literature which aim to shorten the distance between the companies and their customers, to ease the capture and deployment of the customer's requirements, to assist in the grade and rank the requirements and finally, to really understand the chosen requirements and their impacts onto the Product Development Process (PDP), right from the design phase up to the production phase.

QFD – Quality Function Deployment (CLAUSING, 1994), Conjoint Analysis (GREEN and SRINIVASAN, 1978), Pugh

Method (PUGH, 1990), AHP – Analytic Hierarchy Process (SAATY, 1980) are representatives of such methods and techniques. Computer implemented tools are also worth mentioning such as Caliber RM – Collaborative Requirements Management System (FEIBUS, 1998), DOME – DOmain Modeling Environment (WALLACE, D. and K. WANG, 1999), DOORS – Dynamic Object Oriented Requirements System (http://www.telelogic.com/products/doorsers/doors), IRSS – Integrated Requirements Support System (BOOZ-ALLEN & HAMILTON, 1999), and RDD-100 – Requirements Driven Design (ASCENT LOGIC CORPORATION, 1991).

It has been noticed from case studies and literature that the companies do not get the best from the mentioned methods, tools and techniques because the majority of the companies do not have their processes rightly mapped or they do naively believe that a commercial tool or a single method would bring the solution to their problems.

The scenario shown above turned out to be the motivation and challenge for the design of the Requirements Management Process (ReMP) described in this paper. This process is composed of activities that take place along the whole product lifecycle. These activities are: to gather the market and customer's needs, to select and understand the needs, to convert the needs into product requirements followed by their ranking and finally, to follow the requirements up through the product development process.

The paper is structured as follows: Section Two lays down the necessary theoretical background. The proposed process is described in detail in Section Three. Section Four presents and analyses the results of a case study. Key conclusions and further development are presented in Section Five.

## 2. Theoretical Background

The definitions shown below are useful to better understand the proposed process.

### 2.1 Requirements

Requirement is the primary way of communication between the customers and the companies, among the teams within an organisation and between a company and their partners and suppliers.

The requirements do have a number of purposes within a product or service development cycle. Some of them are (TELELOGIC, 2000):

♦ To show clearly the results the customers expect from the product or service;

♦ To describe what the product or service purpose, that is to describe their functionalities;

♦ To track back the origin and history of the eventual modifications;

♦ To act as a guide for all product development phases;

♦ To define responsibilities, partners and subcontractors included;

♦ To allow for systematic procedure for change management and

♦ To communicate the basic product or service configuration (characteristics and functionalities) to all the stakeholders.

### 2.2 Quality Function Deployment (QFD)

According to GUINTA and PRAIZLER (1993), Quality Function Deployment is a simple and logical method, which is implemented through a set of four matrices. The QFD matrices help to determine exactly what the customer wants, how the competitors meet the customer's needs and where there are opportunities niches to be filled out. Moreover, the QFD technique is useful to check whether the company has the necessary resources to fulfil successfully the market niches with the correct quality levels.

PEIXOTO and CARPINETI (1999) pointed out that QFD should be used throughout the product development process and has the aim of assisting the design team to fit the real customers' needs into products or services. Through the matrix set, the requirements posed by the customer are deployed and converted into technical specifications of the product. The QFD matrices can be seen as a mean to support the teamwork as they allow for registering the discussions, evaluating and ranking the requirements. Finally, the matrices are a valuable source of information where the product development process can recur.

Extraction, relation and conversion are the basic operations carried out by the QFD matrices. These operations are explained below:

♦ Extraction means to draw a table from an existing one, that is, to use the elements of a table as a reference to obtain the elements to the other.

♦ Relation is the process of identifying the liaison intensity among two tables a matrix is composed by.

♦ Conversion means to weigh the relative importance of data from one table in relation to the liaisons previously established with other table.

AKAO (1990) states that QFD is the conversion of the customer's requirements into quality characteristics. This is done through a systematic deployment that starts of from requirements and ends up with product characteristics. The total quality of the product is, therefore, the outcome of this relation network.

The first QFD matrix, which is known as "The House of Quality", is also the most important one, according to PEIXOTO and CARPINETI (1999). Within this matrix, the deployment of the customer's requirements into product technical specifications takes place. The performance goals of the product, which are related to those characteristics, can also be recorded in this matrix.

### 2.3 Lifecycle

Generally, a product lifecycle is composed of three processes:

♦ Development;

♦ Manufacturing; and

♦ Customer Service.

CLARK and FUJIMOTO (1991) points out that the Product Development Process (PDP) is the process that transforms market information into the necessary information and resources to be used for the making of a product for commercial aim.

PUGH (1990) defines PDP as "a systematic approach needed right from the identification of the market / customer's needs up to the sale of products which meet those needs. This approach encompasses product, processes, people and organisation".

The production process or manufacturing includes the prototype building and product serialisation phases. Its main target is the materialisation of products, tooling, test specimen and spare parts.

The Customer Service process is focused onto the product operation. The companies have the duty to support the customers amid the operation and maintenance of their products. Some of the typical activities of this process include: customer training, spare parts logistics, technical publication availability, follow up of the product operational performance, the definition, negotiation and monitoring of the product warranties and finally, product and components maintenance.

### 2.4 Phases of the Product Development Process

The strategic importance of the product development process for the companies competitiveness has been stressed by many authors and case studies. According to CLARK and FUJIMOTO (1991), the development of new product has become the focal point of the worldwide competitiveness. A number of evidences show that the effective development of new products has an outstanding impact onto costs, quality, customer's satisfaction and companies competitive advantage.

The Product Development Process (PDP) can be defined (CLARK and FUJIMOTO, 1991) as a process by which an organisation transforms market opportunities and technical possibilities data into information and resources necessary to the manufacturing of a commercial product. At the end, this process covers marketing, product engineering and manufacturing functions as well as almost the remaining areas of a company.

PDP is typically structured into several phases or stages. A number of authors present different structures for the PDP. The differences are due to the specificity of the process and the particular needs of each case.

WHEELWRIGHT and CLARK (1992) depict a classical four-phase sequence. These are: conceptual development, product planning, product and process engineering and pilot production followed by the production ramp up.

HAMERI and NIHTILA (1998) propose a product lifecycle for "one-of-a-kind" projects. This cycle is constituted by the following phases: conceptual phase, design phase, manufacturing and operation phases.

The Product Development Process phases of the case study company is shown in Figure 1.

The initial phases of the lifecycle, whatever model is adopted by the companies, are essential for the Requirements Management Process.

IPD – Integrated Product Development is the name given to the product development process at the case study company IPD starts of with a fuzzy stage, which is regarded

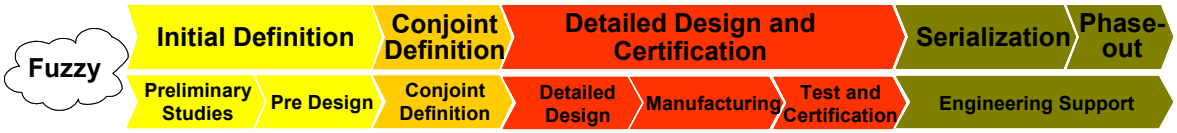


**Figure 1**: Product Development Process phases of the case study company

as a non official phase of IPD. This is detailed further below. Then, the Preliminary Studies is the first, official phase of IPD. This phase encloses technical viability and economical competitiveness analyses of the product under development. These analyses have already been done preliminarily in the fuzzy phase of the process. At Preliminary Studies, however more details are brought into the analysis. An important outcome of this phase is to check whether a new proposal is aligned with the strategic goals of the company. To this end, a number of studies are conducted, such as: restrictions imposed by the regulatory authorities, technological capability, manufacturing and materials constraints, only to name a few.

The next phase, Pre Design, is characterised by strong engineering trade-offs. The product is detailed at this phase, based on a definitive configuration, otherwise the development of systems proposals could not take place.

The Pre Design Team, that is composed by specialists of several areas such as product engineering, manufacturing, certification, customer service and quality assurance, proposes solutions for the product in accordance with the customers requirements.

The description of the remaining IPD phases can be found at ARAÚJO AND CRUZ (2000).

### 2.5 Phase Review

Phase reviews are checkpoints similar to quality checks in manufacturing. (COOPER, 1993). The phase review process within PDP phase consists of a managerial review that usually takes place at the end of each development phase. The goal of such reviews is twofold: the evaluation of the continuity of the project and the risks associated with this decision. Furthermore, the resources needed for the project continuity are approved in the review meetings (CROW, 1998). The decisions taken are based on well-defined stage gate criteria, which come from strategy, marketing, engineering, manufacturing, finance and quality areas as a way to take into account all the main project stakeholders.

## 3. The proposed Requirements Management Process (ReMP)

The process described herein has been developed to meet the particularities and formalisation needs of the aerospace industry. It is worth mentioning that the methods and statements that are used to describe it do not reflect the views of the company that is taken as a case study. These are proposals put forward by the authors.

The Requirements Management Process has been developed based upon the three main sources listed below:

♦ Best practices available in the literature which exploits processes and techniques;

♦ Lessons learned from other companies from different industrial sectors;

♦ Exploratory interviews with senior persons from the organisation in order to gather knowledge about the company business aspects and internal particularities.

Once the necessary information had been gathered, a model for ReMP has been built. The modelling brought forward the definitions of the activities and their managers, as well as their inputs and outputs. It has been adopted as a modelling directive the usage of concepts and procedures well established and used by other companies. Normally these companies were not from the aerospace sector. Then, an adaptation effort was necessary to fit those practices into the aerospace scenario.

Formalisation and traceability have been chosen as the main goals for the ReMP proposal. The former allows for the writing of the requirements list, their deployment and ownership attribution to occur in a procedural way; the latter guarantees that each requirement is associated to a customer need and is deployed, at least, into another requirement. Traceability also allows for setting up the relationship among the requirements and the validation procedures designed for them.

Figure 2 depicts the main activities of the Requirements Management Process, the documentation and their

placement at the product development reference model used by the case study company.

It can be observed from Figure 2 that the ReMP model consists of two sub processes: Requirements Definition and Requirements Management.

### 3.1 Requirements Definition

This sub process is critical to the understanding, deployment and incorporation of the customer's needs into the product design. Once the requirements are defined (popularly, "frozen"), they drive the product development process as a whole. Next, the description of the main activities of this sub-process is presented.

#### *3.1.1 To gather and to understand the customer's needs*

The first activity of the process is to survey and gather the needs of the prospect customers. Exploratory, deterministic and causal are the possible forms of survey. Further details are found in (MATTAR, 1996). The customers are also request to help the company to weigh their needs.

The information collected should be stored in a systematic way, without any interpretation. Key to the success of this activity is to write exactly what the customer said, word-by-word. To write an interpretation of what has been said implies risk of loosing the original meaning of the customers' needs (GUINTA and PRAIZLER, 1993).

It is known that frequently the people who are responsible to enquire the customers' necessities have technical background of the product. Consequently they interpret what is being said by the customer during the survey. This might prejudice the product development process as a detail or even a requirement could be discharged or not completely analysed. Another possible problem is to limit the solutions domain for the problems pointed out by the customers.

GUINTA and PRAIZLER (1993) suggest that there are four levels of the customers' needs. These are expected, explicit, implicit and unexpected. The company ought to identify and meet the requirements of each level prior to move to the next.

There are cases where the customers themselves suggest solutions. If that is the case, their comments and ideas have to be registered; however to encourage them to choose a particular solution is a mistake.

On the other hand, the customers either do not know clearly their own problems or have difficulties to explain them. It is a duty of the surveyor to help them in this matter. However, no solution should put forward by him.

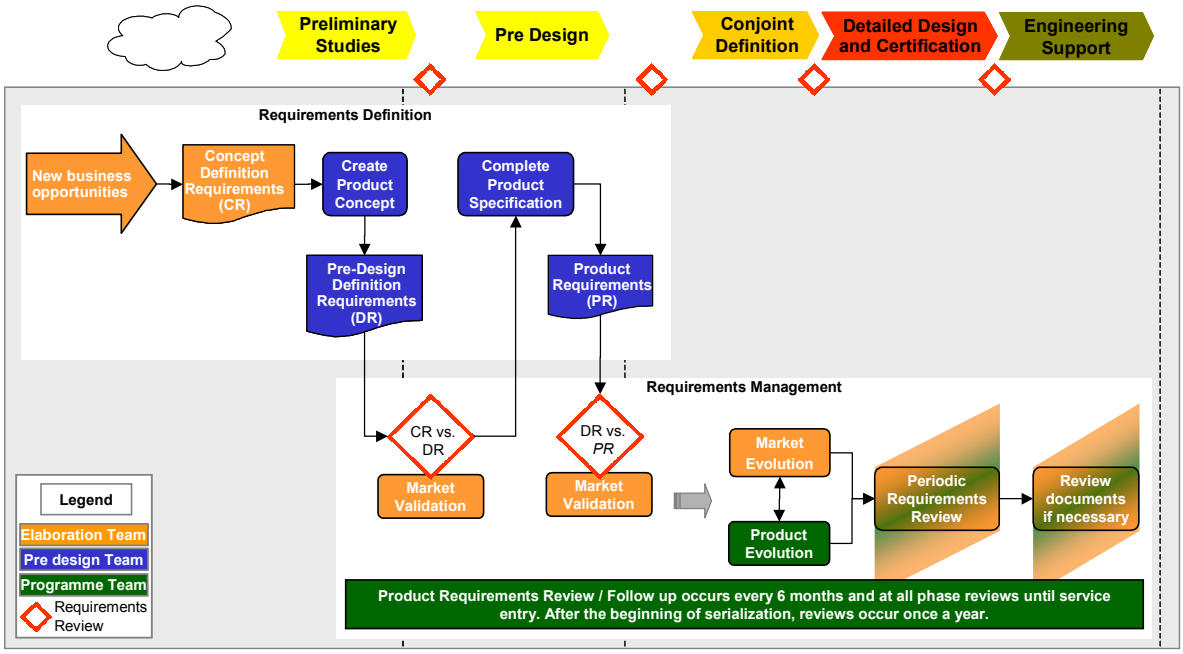


**Figure 2**: Activities and documents of the ReMP

***Centralisation***

The companies usually have several channels where customers' needs, complaints and suggestions for improvements arrive to. Examples are: customer support, sales and contract management. To allow that the collected information is properly analysed, the ReMP model foresees an activity that centralises the information. This activity is assigned to the market intelligence area of the company, whose main goal is to guarantee that the information is stored in a common database. This procedure avoids information redundancy and increases the reliability of the information content.

***Deployment***

The next ReMP activity is the conversion of the gathered needs into requirements. Actually, this is the first information deployment, which is well known in the literature as the Voice of Quality or the First Matrix of QFD – Quality Function Deployment. The requirements should be clear, complete, consistent, traceable and measurable. The task of information deployment is a challenge on its own; however two more challenges have to be faced: the assignment of a person responsible for the requirement (the requirement owner) and the definition of a measurement associated to the requirement. Due to multidisciplinary nature of the deployed requirements, the participation of people of all specialities and areas related to the requirements is mandatory.

In order to ease the communication and integration among these people, the creation of a team is proposed. The named Elaboration Team, should be composed by representatives from commercial, sales, marketing, market intelligence, contract management, customer support and engineering areas. To this team is assigned the task of market survey and the first deployment of the customers' needs.

***Validation and inner prioritisation***

Another job of the Elaboration Team is to check the conflicts or incompatibilities among the requirements. The outcome of this activity is a balanced solution that meets the expectative of both customers and company. Fundamental to the success of this job is to record the decisions made, rendering them transparent to all stakeholders: customers, company, partners, suppliers and certification authority.

The Elaboration Team analyses the requirements set to guarantee that the product under development does have a differential appeal, i.e., a competitive advantage that is noticeable by the future users. The relevance of innovation is strictly related with the real needs and maturity of the customers.

Yet, another essential aspect related to either product differentiation or innovation is the definition of the launching time of a product or technology. The choice of the ideal timing can determine the product success or failure as the customers might not be prepared to pay for a new functionality or service or even they might not be mature enough to cope with the innovation presented to them. The market jargons "to enchant the customer" and "to exceed the customer expectations" are not as efficient as before. It is a duty of the Elaboration Team to analyse the market tendencies, the competitors and their customers to determine the precise timing for putting forward the companies' solutions.

***Validation and prioritisation of the requirements with prospective customers***

Once the internal analyses undertaken by the Elaboration Team are completed, sales and marketing representatives ought to come back to market to validate the proposed requirements and to guarantee that the correct understanding among the prospective customers have been achieved. It is suggested to the customers to rank the requirements according to their vision and needs. To assist them with this activity, some method or technique should be instructed in order to avoid that the customer weighs all requirements equally. A number of techniques can be used to this end: AHP – Analytic Hierarchy Process (SAATY, 1980), Conjoint Analysis (GREEN and SRINIVASAN, 1978) and QFD – Quality Function Deployment (CLAUSING, 1994).

***To Consolidate Definition Requirements***

The requirements, which were validated with the potential users of the product, are the contents of a formal document named Concept Definition Requirements (CR). This document has the necessary market and customer's requirements for the Preliminary Study phase of the Product Development Process. It also defines the features and quality levels the prospective customers expect from the product. The formalisation of the CR signals the starting point of the Product Development Process through the Preliminary Study phase.

#### *3.1.2 Elaboration of a product proposal*

The Pre Design Team exploits the *Concept Definition Requirements* to draw a product proposal. This proposal is achieved through analysis and synthesis of a number of product configuration alternatives. The Pre Design Team converts the requirements into product attributes or characteristics, i.e. information which defines physical and tangible aspects of the product to be, such as main dimensions, geometrical shape, assembly overview of the main systems and components, weight, power plant definition, performance data, among others.

Then, the sales and marketing representatives show to the market and prospective customers the possible product configurations in order to validate them. This is extremely important as many suggestions and decisions take place when the customers are exposed to the product outline. New or complementary requirements are brought forward by a specific customer, by the cumulative knowledge of the market and product or even by the sales and marketing persons themselves. The company must be aware and prepared to take into account new requirements as they might influence the product development process as a whole. Novel business opportunities for the company might spin off from this new set of requirements as long as the company is capable to fit them into the ongoing Product Development Process.

The initial product conception is then translated into a document named *Product Preliminary Specification (PPS)*. The technical requirements, which come from the preliminary specification of the product together with the complementary market requirements, are consolidated in a single document named *Pre Design Requirements (DR)*. The contents of this document sums up the necessary technical information to initiate the next phase of the product development process, which is the Pre Design phase.

In some circumstances not all requirements can be fulfilled at once. It is, therefore, important to keep their records so that they can be worked out later, possibly in a new version of the product.

#### *3.1.3 Completion of the Product Conception*

Once the product proposal is validated, the engineering "trade-offs" of the Pre Design phase take place. The goal of this activity is to obtain a balanced solution which suits all the involved areas such as engineering, production, customer support, quality and so on. The inputs for this phase are the documents *Preliminary Product Specification* and the *Pre Design Requirements (DR)*.

This phase ends up with the definition of the main product characteristics, functionalities and systems. These are, among others: conception, architecture and basic data of the main systems such as interior and structure, weight and speed envelops, prime component list (ABC classification), manufacturing technologies and processes tooling design, quality and test procedures, Digital Mock-Up (DMU) and preliminary product structure (technical list). All the information that comes from the definitions above is the contents of a document named *Product Technical Specification (PTS)*. The essence of this document is then translated into a requirements document, *Product Requirements (PR)*, which will become a reference document used to manage the requirements during the whole Product Development Process.

The requirements are then classified and clustered into categories according to the perceived value for the customers and the market. This procedure has been proven useful to guarantee the right and easy management of the requirements. The *PR* contains the following categories: performance, operations, maintenance, engine, environment, and interior.

The end of the Pre Design phase also signals the end of the initial part of the Requirements Management Process (ReMP).

### 3.2 Requirements Management

The formalisation of the ReMP is the sole guarantee that the requirements that are defined at the very beginning of the Product Development Process will certainly be present in the final version of the product. The requirements management actions occur at all the phase review meetings what renders the necessary formalisation to the process.

The first Requirements Review is done by the Elaboration Team and the Pre design Team. The contents of the *CR* and *DR* documents are compared. The Requirements Review is a specific meeting prior to the Phase Review meeting and calls for the participation of representatives of engineering, market intelligence and strategic planning areas.

The following review meeting takes place just before the end of the Pre Design phase. This meeting checks the contents

of the *DR* and *PR* documents. This meeting also precedes a Phase Review meeting. Now, the representatives of the Programme Team join in the persons of the previous requirements meeting. The Programme Team is a multi-functional team formed by the area leaders of the company such as engineering, manufacturing, tooling, quality, tests, and certification that work on the product development after the Pre Design phase.

After completing the Pre Design review, the product development and management responsibility, and therefore the requirements management, is transferred to the Programme Team. The requirements review meetings must take place in all product phase reviews or in a 6-month frequency or at any time if major market or product changes are identified. These meetings are held at annual basis after the Serialisation phase.

**4. Case Study**

A case study has been made up to exemplify the ReMP model proposed herein. The objective of this case is to simulate the requirements definition process, in a step-by-step fashion so that all the activities described before are analysed in detail. After the definition phase, the case study goes on up to the management phase.

Suppose that a number of meetings were held with prospect customers. As outcome of such meetings, there were identified three particular needs for an aircraft, which are:

♦ "transport 14 passengers";

♦ "fly from Rio de Janeiro to Paris, non stop"; and

♦ "take off from Denver".

Once the customer needs were correctly understood, the first information deployment takes place. For the sake of simplicity, the needs expressed by the prospect customers are deployed into only four requirements. According to the ReMP nomenclature, these requirements are actually the *Concept Definition Requirements (CR)*. These are listed below.

♦ CR1 – Aircraft that accommodates 14 passengers, considering pax average weight (including hand luggage) + dispatched luggage equal to 100 kg;

♦ CR2 – Aircraft range superior to 9500 km, at 0.8 Mach cruise speed, and maximum take-off weight equals to 33,000 kg;

♦ CR3 – Paris noise level requirements (Charles de Gaulle airport): STAGE IV;

♦ CR4 – Runway performance: (Restrictions: 1- Santos Dumont Airport – obstacle presence and short runway, 2- Denver International Airport – 5431ft altitude).

- CR4.1 – Take-off distance at maximum take-off weight (sea level, ISA, 14 PAX + 500 Kg baggage compartment + fuel for a mission of 1850 m) < 1,500 m;
- CR4.2 – Landing distance (14 PAX + 500 Kg baggage compartment + fuel for a mission of 926 m) < 1,250 m;
- CR4.3 – Operating capability: 6000 ft altitude – maximum take-off weight limitation;
- CR4.4 – Rate of climb of 2,4 %;

The deployment task is done by the Elaboration Team. At this moment, this team must also identify conflicting requirements, like the CR 1 and CR 4.3. Finding a solution, e.g. a product concept that attends to both requirements is considered a challenge. The most important issue is to develop an aircraft that operates either at sea level or at Denver, carrying 14 passengers, with the same performance and cost levels. This implies that an initial requirement will not be completely fulfilled. An important point at this stage is to make clear this situation and ask the customers which option will better suit their requests.

After all the requirements are written down in a clear, concise and verifiable way, a validation within the market can be done. Once these requirements are consolidated, they are actually the contents of document *Concept Definition Requirements (CR)*.

The Pre Design Team starts up the product conception that meets the requirements stated above. The product proposal, resulted from this activity, is then compiled in the *Product Preliminary Specification (PPS)*. This document presents the conceptual design, e.g., it describes the basic characteristics of the aircraft, which are the results of preliminary studies of the physical arrangements and of detailed / comprehensive / simplified engineering analyses. The typical content of this document comprises:

♦ PPS1 – Three views and main dimensions;

♦ PPS 2 – Wings, horizontal and vertical tails position;

♦ PPS 3 – Internal configuration alternatives;

♦ PPS 4 – Cabin height;

♦ PPS 5 – Seat width;

♦ PPS 6 – Aisle width;

♦ PPS 7 – Overhead bins volume;

♦ PPS 8 – Windows (position, size, pace).

These features are shown in Figure 3.

The requirements related to this conception, *Pre-Design Definition Requirements (DR)*, contain:

♦ Concept Technical Requirements:

- DR 1 – Number of engines: 2;
- DR 2 – Engine thrust: 10.000 lb;
- DR 3 – Fuel capacity: 9000 kg;
- DR 4 – Wingspan: 19,5 meters;
- DR 5 – Wing area: 40 square meters;
- DR 6 – Sweep angle: 30 degrees;
- DR 7 – Aspect ratio: 7,6.

♦ Complementary Market Requirements:

- DR8 – Maintenance requirements: maintenance cost (US$/FH), maintenance types, maintenance intervals;
- DR 9 – Performance requirements.

In the Preliminary Studies phase review, the *DR* document, which represents the product concept, must be checked against the *CR* document that represents the customer requirements.

Throughout the entire Pre Design phase, the Pre Design Team uses the *Product Preliminary Specification* and the *Pre-Design Definition Requirements* to detail the product concept. The further deployment of any *Concept Technical Requirement* is done through the compatibility analysis to the *Product Preliminary Specification*. For instance, the deployment of the fuel system could contain the following information:

♦ Fuel System basic data and architecture;

♦ Fuel System layout installation;

♦ Fuel System zonal analysis;

♦ Fuel System Safety Assessment.

The fuel system characteristics described above are called *Product Technical Specification (PTS)*. The main issues of this document are translated into *Product Requirements (PR)*. For the fuel system mentioned above, the requirements could be:

♦ PR 1 – Fuel capacity in the wing tanks: 9000 kg;

♦ PR 2 – Non useful fuel: 90 kg;

♦ PR 3 – Fuel temperature range: – 40° C a 52° C;

♦ PR 4 – Maximum fuel flow to the engine: 7000 pph(pounds per hour);

♦ PR 5 – Maximum fuel flow to the APU (Auxiliary Power Unit): 300 pph;

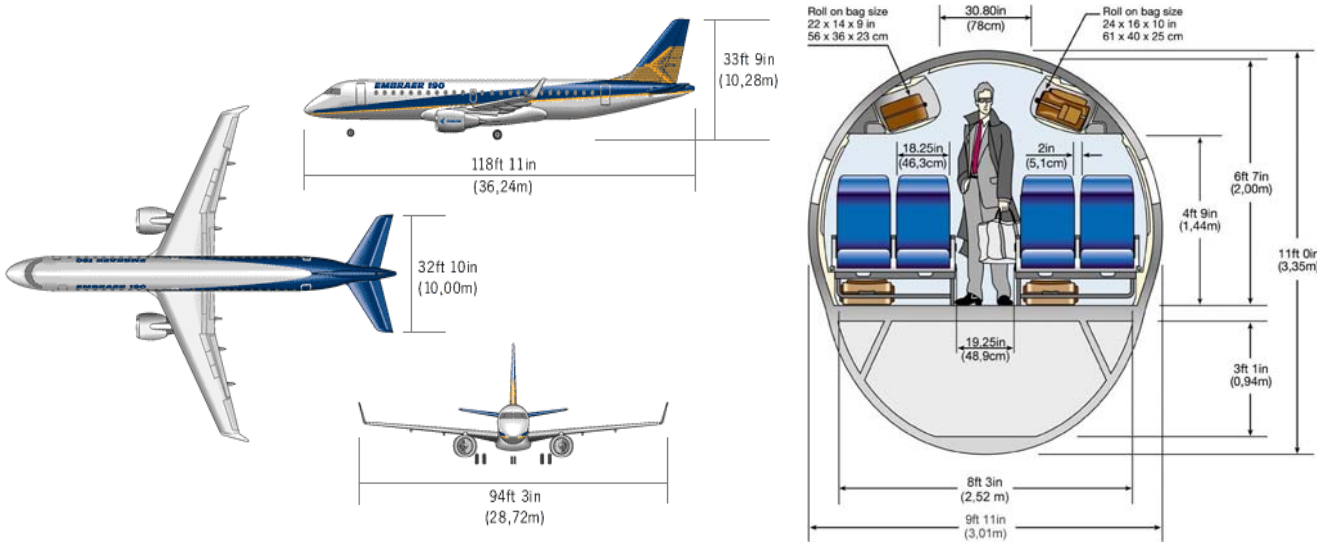


**Figure 3**: Product Features set up at Product Preliminary Specification

♦ PR 6 – Fuel unbalanced alarm activated when unevenness reaches 350 kg.

The Product Requirements described above would become the reference or base line to the following Product Development Process (PDP) phases.

At the end of the Pre Design phase, another Requirements Review is performed. The *PR* is checked against the *DR* document, in order to guarantee that the product concept remains aligned to the customer needs.

After this phase, there is a Requirements Review every six months and at all phase review, until the aircraft enters in operation. After the serialization milestone, these reviews occur once a year, or whenever necessary.

The requirements review comprehend, basically, both market and product evolution analyses. First, the Elaboration Team presents the market requirements analysis; then a second round takes place where the Programme Team presents the status of the product development, that is, how adherent is the product to the initial requirements. Both teams have to discuss on a final list which express an agreement between their views.Whenever a requirement needs to be modified, then the *Product Requirements* document must be reviewed.

## 5. Conclusions

A novel process for requirements management (ReMP) has been presented. This process is extremely focused on the customers, since it comprehends activities that encourage the customers' collaboration throughout the entire Product Development Process.

The implementation of this process and its correct utilization has allowed the formalization and better traceability of the customers´ requirements. Consequently, the likelihood of a company to develop a product that fulfills most of market requirements increases substantially.

The ReMP is at the initial implementation phase in an aerospace company. So far, the most significant results obtained are the following: the creation of explicit documentation of customer requirements; the early definition of the requirements' ownership; a single database, which avoids redundant information and increases reliability and traceability among requirements. A made up case study has been presented in order to illustrate the application of the proposed method. Even though it is a simple example, it meets the purpose of observing that the writing up of the ReMP general documents in a practical case is straightforward.

Further activities of this work include the definition of templates, or reference lists of the requirements for each PDP phase and the identification of uncertainty levels for these requirements. The requirements modification impact analysis is also an important issue to be pursued.

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