



FABRICAÇÃO AERONÁUTICA

Aeronautical Manufacturing



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- EASA PART 21



DEFINIÇÃO DE FABRICAÇÃO AERONÁUTICA

Não existe uma definição única para fabricação aeronáutica.

A que se adopta é a seguinte:

- fabricação aeronáutica é o conjunto articulado e organizado de actividades de engenharia, logística, qualidade e de produção, que com base nas especificações de projecto, incluem a manufactura de peças simples, formação de conjuntos e montagem de itens com aplicação aeronáutica (aeronaves, motores ou quaisquer outros).**

Produção aeronáutica em termos sucintos inclui assim todas as actividades inerentes à manufactura de peças simples e a montagem.

Pode ainda definir-se produção aeronáutica como o conjunto de actividades recorrentes e não recorrentes associadas à construção de aeronaves, motores ou quaisquer outros itens com aplicação aeronáutica.

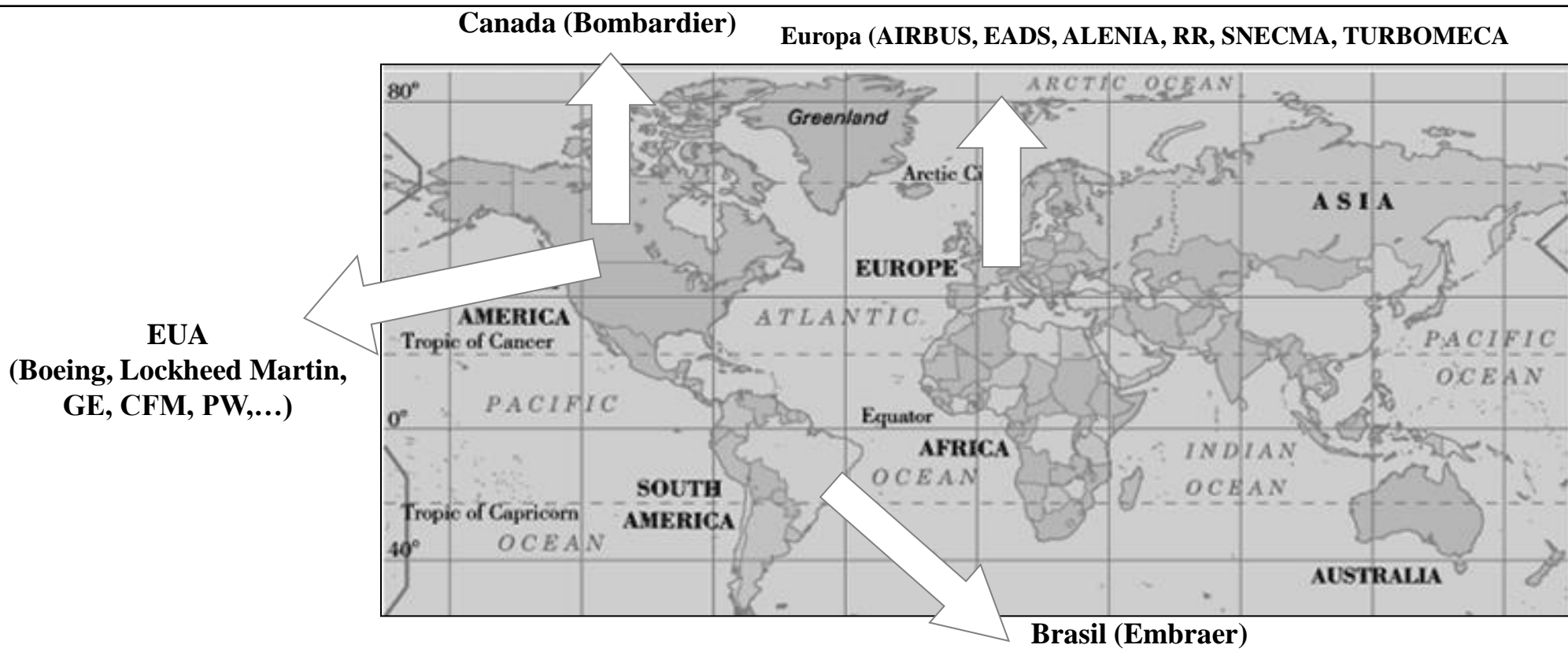
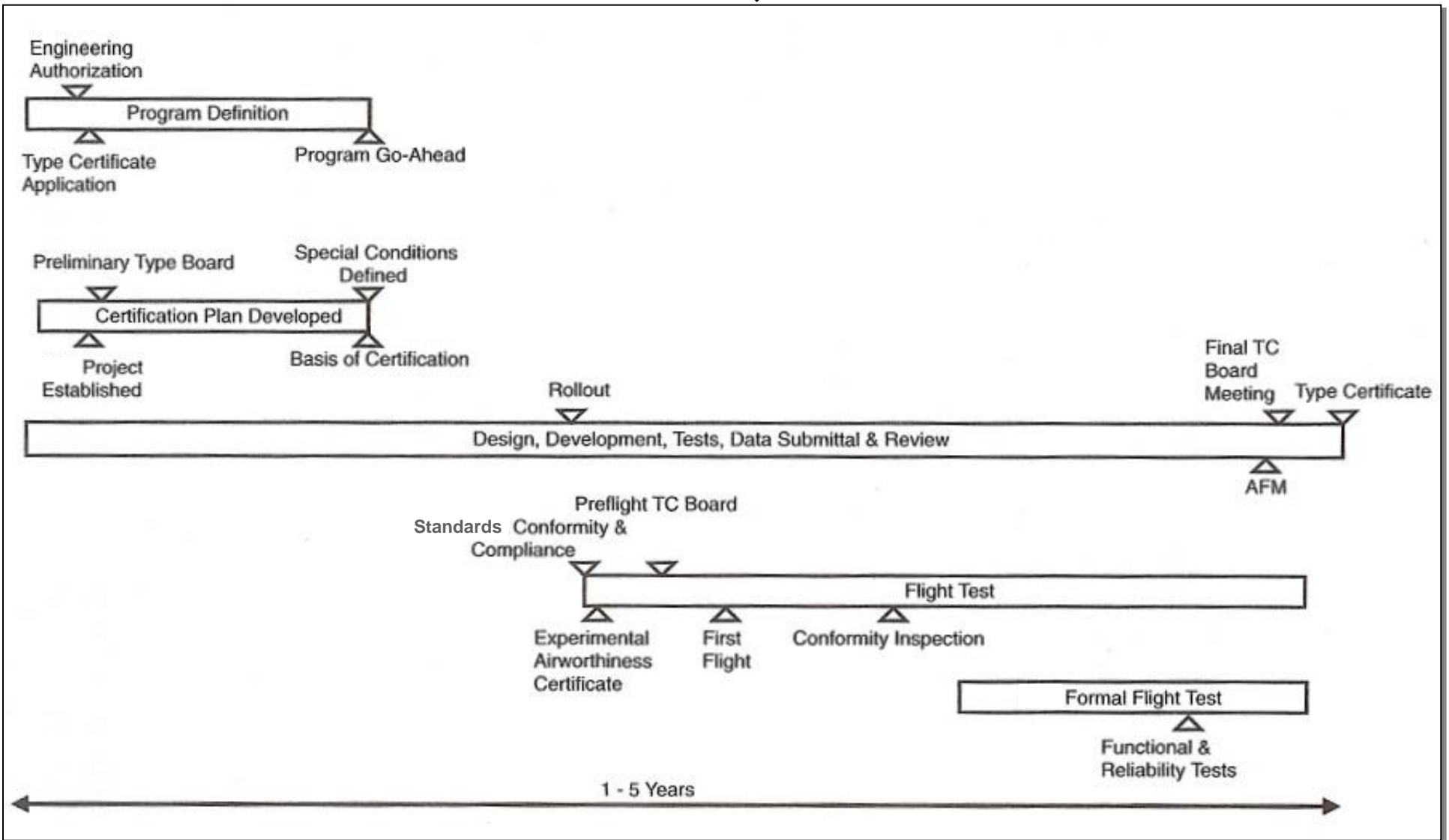


Fig 1 - Principais fabricantes mundiais de material aeronáutico

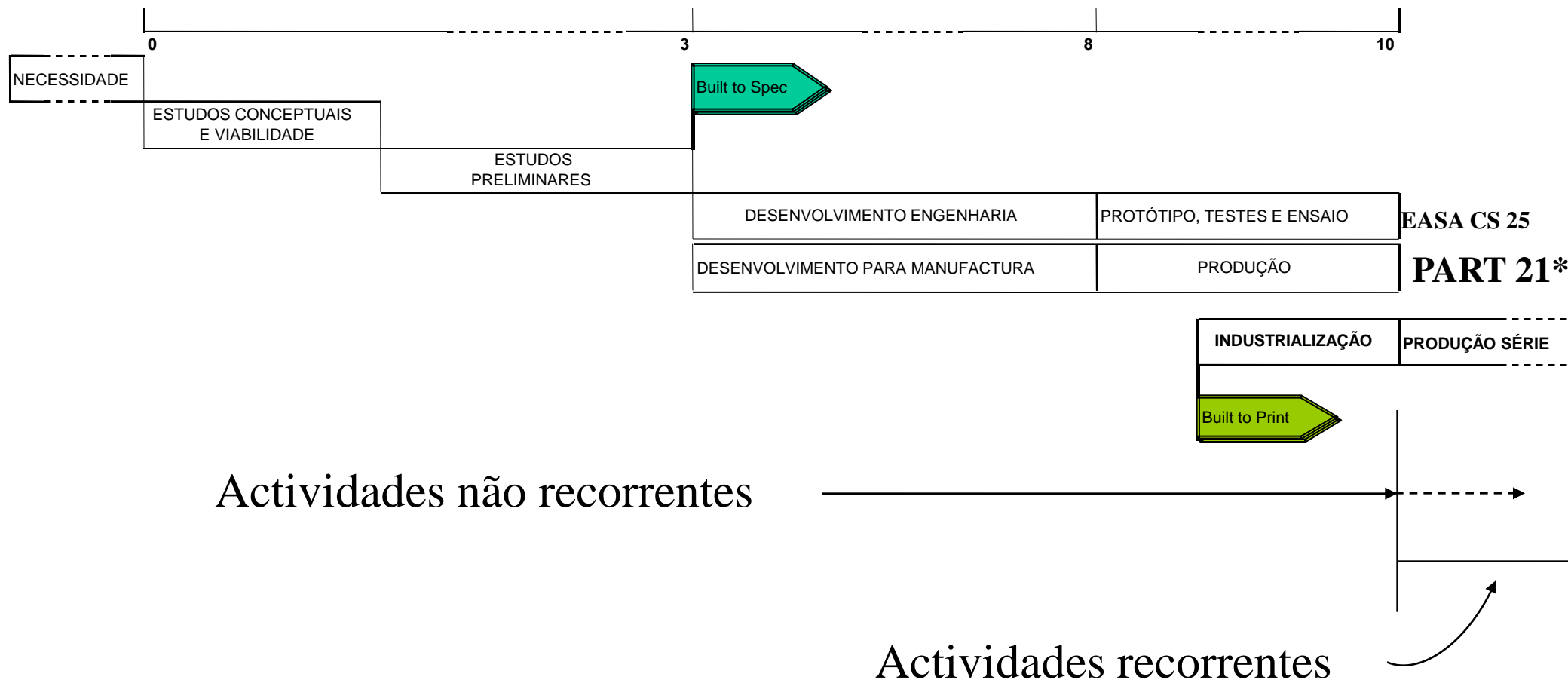


CICLO DE VIDA DE PROJECTO AERONÁUTICO





CICLO DE VIDA DE PRODUÇÃO AERONÁUTICA



* FAR 21/EASA PART 21



O CASO PORTUGUÊS

Em Portugal a empresa que lidera o processo que tem servido como motor para a criação de outras é a OGMA (sediada em Alverca).

Em torno da OGMA nasceram pequenas unidades industriais dedicadas à fabricação de peças simples (maquinação) e montagem de conjuntos.

O trabalho de fabricação aeronáutica (aeronaves e motores) remonta à década de 1950 tendo sido posteriormente reduzido drasticamente devido ao esforço de manutenção que o teatro de guerra ultramarino exigia.

Durante a década de 1980 regressou-se progressivamente à manufactura de partes de aeronaves e de seus componentes, com especial ênfase no fabrico metálico e compósito.

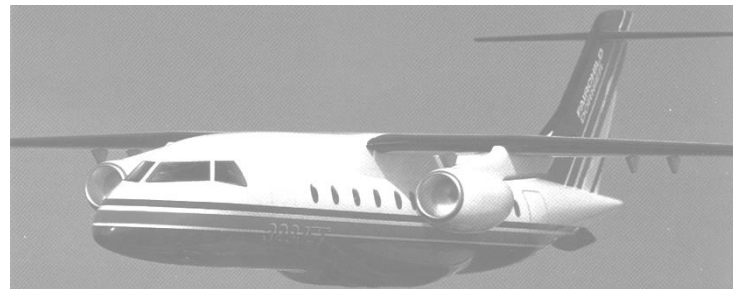
A página seguinte apresenta alguns exemplos da actual capacidade nacional instalada, isto é, do tipo de manufacturas que se tem feito até ao presente.

Caixão central da asa (wing box)



**Montagem da célula, asas e estabilizador
e fabricação de elementos em compósito**

Secções da fuselagem (fabricação e montagem)



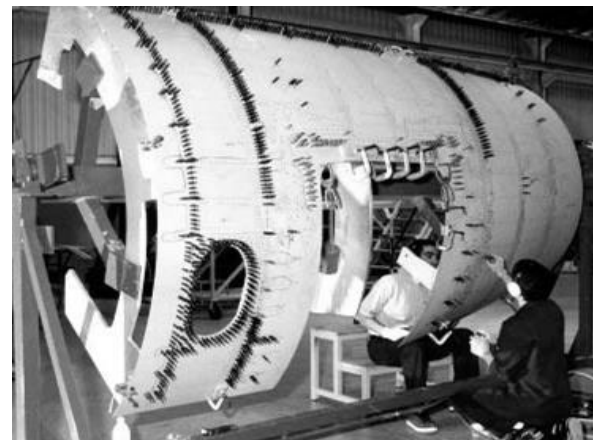
Outras actividades de fabricação e montagem

- consolas;
- armários;
- trens de aterragem;
- escada de emergência;
- estruturas primárias da cabine de helicópteros;
- portas de nacelle.
- pylons de fixação de motores

EXEMPLOS DE MANUFATURA AERONÁUTICA NACIONAL



Pilatus PC XII - fuselagem



DO328 - Sector de Fuselagem



DO728 – caixão central da asa (*central wing box*)



INDUSTRIALIZAÇÃO - GENERALIDADES

Definição de industrialização

Conjunto de actividades de natureza não recorrente envolvendo a engenharia, a qualidade, a logística e fabricos tendentes a permitir a produção série.

Opção de fabrico “Built to spec”

É fabrico que envolve projecto contra especificação preliminar (da aeronave ou sistema) ou se quisermos é o tipo de manufactura que engloba prévio desenvolvimento detalhado dos artigos a manufacturar.

Opção de fabrico “*Built to print*”

É fabrico contra especificação final ou se quisermos é o tipo de manufactura que não engloba o projecto dos componentes a manufacturar.

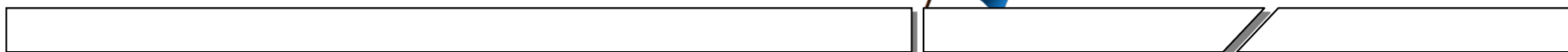


Actividades Não Recorrentes Non Recurring Activities	Actividades Recorrente Recurring activities
Projecto preliminar – conceptual design Projecto de detalhe – detailed design Industrialização - industrialization Fabricação de protótipos – prototypes Suporte - In-servise support Modificações - In service modifications	Produção série – series production

Project Phase



In-service

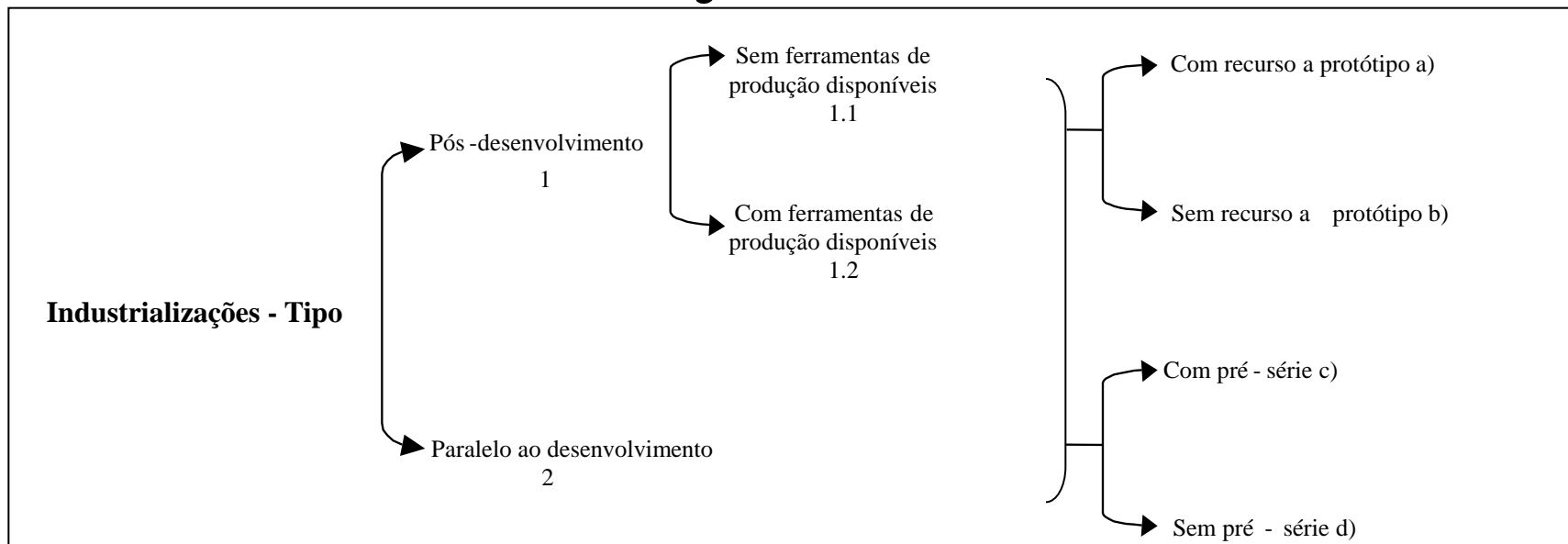


TC

Projecto preliminar – conceptual design
Projecto de detalhe – detailed design
Industrialização - industrialization
Fabricação de protótipos – prototypes

Produção Série / Series production
Suporte - In-servise support
Modificações - In service modifications

INDUSTRIALIZAÇÃO – TIPOS CONTRATUAIS

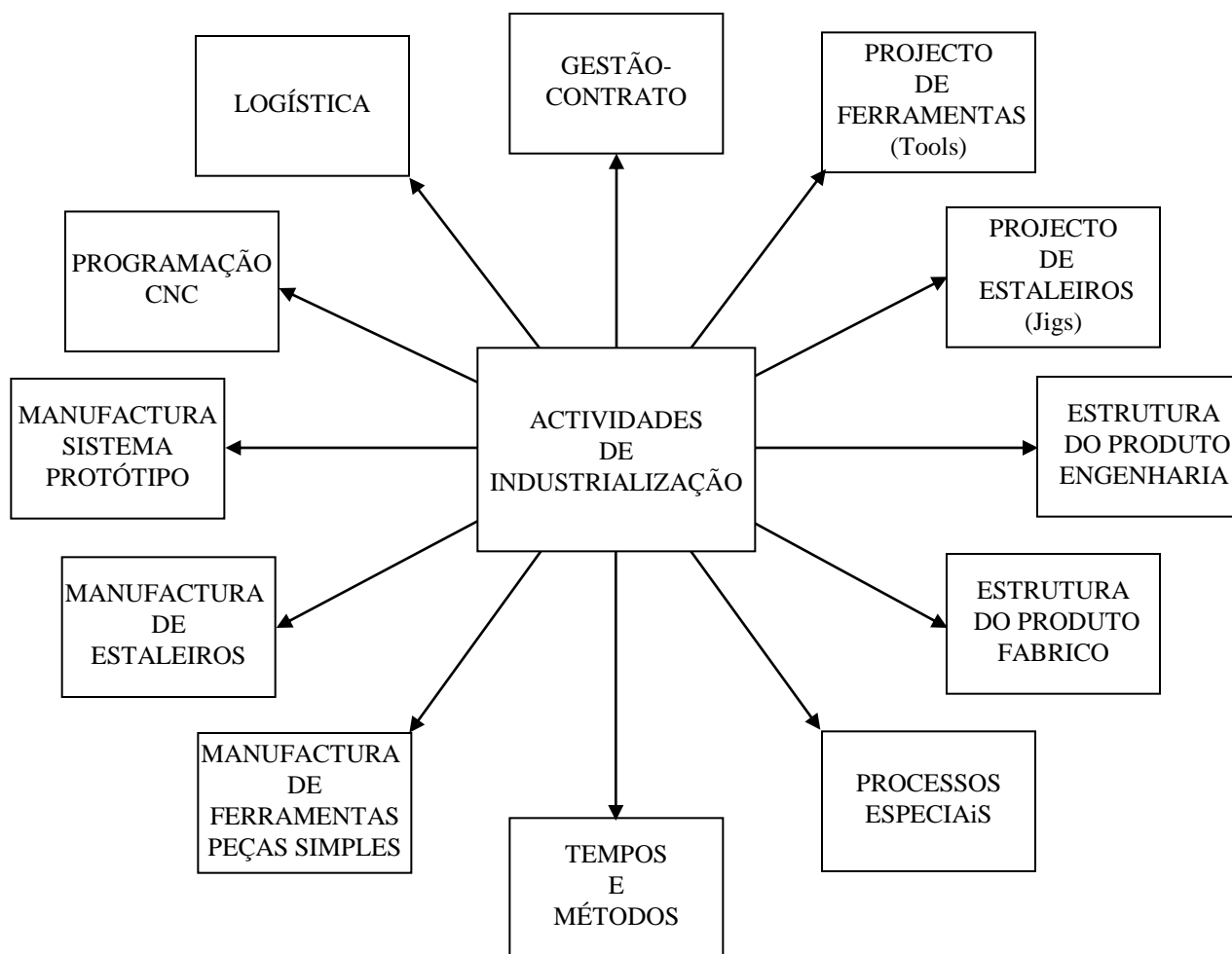


Modalidade de envolvimento na manufactura & Exemplos

- | | |
|-----------|---|
| 1 | Subcontratações (<i>build to print</i>); |
| 2 | Parcerias de projecto (programas de <i>risk e cost sharing</i>): |
| | - FLA/A400M - Alphajet - Airbus; |
| | - Tornado - EFA - Embraer. |
| 1.1 | Nacelle para C- 130J; |
| 1.2 | Pilatus (green aircraft); |
| 1.1a e 2b | Consolas para Awacs; |
| 1.2 b | Dornier 328; |
| 2.c | A400M. |

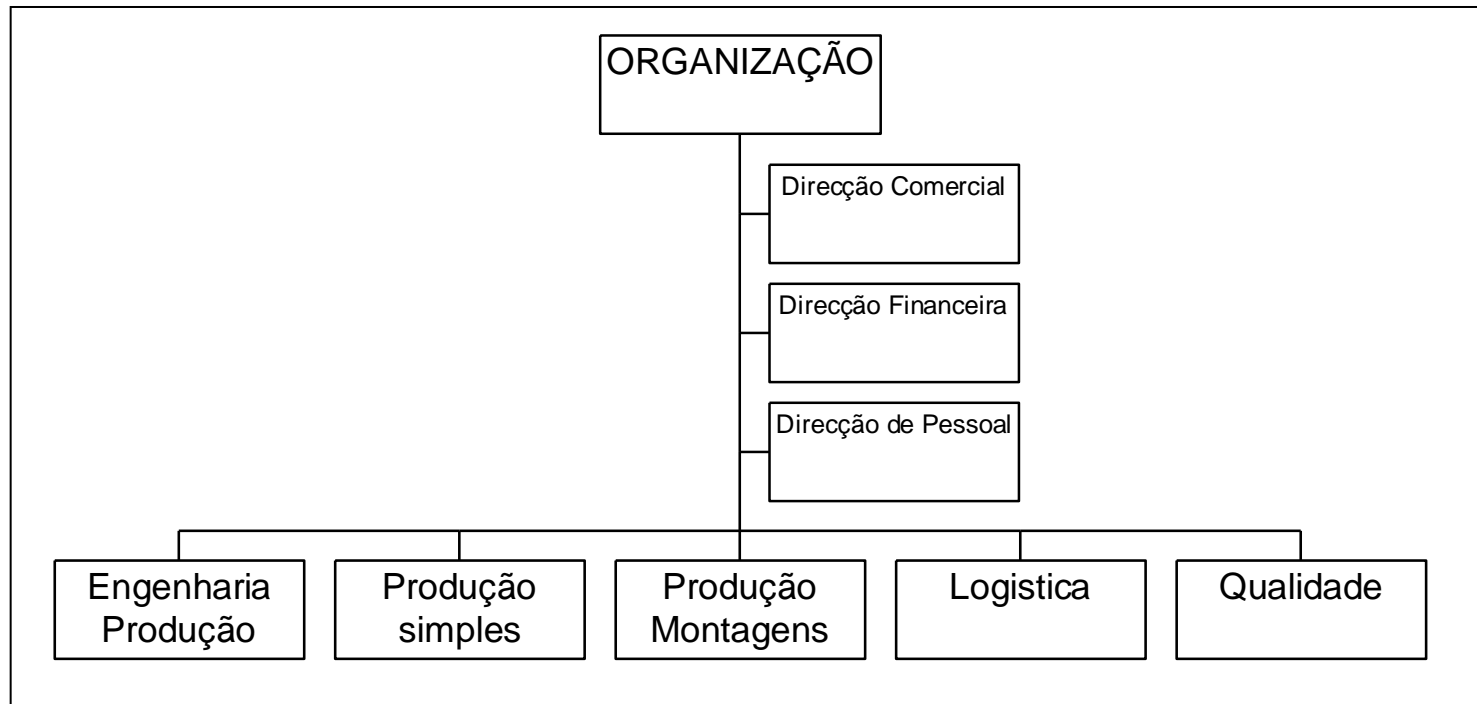


INDUSTRIALIZAÇÃO “BUILT TO PRINT” ACTIVIDADES





Organizações - Modelo simplificado



A figura representa as áreas chave típicas de uma organização de produção:

- Engenharia de Produção – estruturante das actividades
- Produção de peças simples – área tecnológica
- Produção montagens – formação de sub-conjuntos e de conjuntos;
- Logística – abastecimento de matéria prima
- Qualidade – controlo de processos



REGULAMENTAÇÃO AERONÁUTICA

SISTEMAS DE QUALIDADE

Necessidade de regulamentação EASA PART 21

Aspectos chaves:

- controlo documental e de responsabilidades no processo;
- uniformizar procedimentos que garantam a aeronavegabilidade dos produtos e compatibilidade ambiental;
- Assegurar que o fabrico é feito por organizações devidamente credenciadas para o efeito.



Programas multinacionais - exemplo
Multinational programmes

COMMISSION REGULATION (EC) no 1702/2003 - EASA PART 21 FOREWORD

It is necessary to adopt common technical requirements and administrative procedures to ensure the airworthiness and environmental compatibility of aeronautical products, parts and appliances, subject to the basic Regulation; such requirements and procedures should specify the conditions to issue, maintain, amend, suspend or revoke the appropriate certificates.

Organisations involved in the design and production of products, parts and appliances should be required to comply with certain technical requirements ...

The need to ensure uniformity in the application of common airworthiness and environmental requirements for aeronautical products, parts and appliances requires that common procedures be followed by the competent authorities of the Member States and, where applicable, the Agency to assess compliance with these requirements;



Fabricação de cablagens eléctricas
Harnesses/Wiring/looming



EASA PART 21

SECTION A - REQUIREMENTS FOR APPLICANTS AND ACQUIRED RIGHTS AND OBLIGATIONS

SUBPART A — GENERAL PROVISIONS

SUBPART B — TYPE-CERTIFICATES AND RESTRICTED TYPE-CERTIFICATES

(SUBPART C — NOT APPLICABLE)

SUBPART D — CHANGES TO TYPE-CERTIFICATES AND RESTRICTED TYPE-CERTIFICATES

SUBPART E — SUPPLEMENTAL TYPE-CERTIFICATES

SUBPART F — PRODUCTION WITHOUT PRODUCTION ORGANISATION APPROVAL

SUBPART G — PRODUCTION ORGANISATION APPROVAL

SUBPART H — AIRWORTHINESS CERTIFICATES

SUBPART I — NOISE CERTIFICATES

SUBPART J — DESIGN ORGANISATION APPROVAL

SUBPART K — PARTS AND APPLIANCES

(SUBPART L — NOT APPLICABLE)

SUBPART M — REPAIRS

SUBPART N — NOT APPLICABLE)

SUBPART O — EUROPEAN TECHNICAL STANDARD ORDER AUTHORISATIONS

(SUBPART P — NOT APPLICABLE)

SUBPART Q — IDENTIFICATION OF PRODUCTS, PARTS AND APPLIANCES



EEA PART 21

SECTION A

REQUIREMENTS FOR APPLICANTS AND ACQUIRED RIGHTS AND OBLIGATIONS

SUBPART A — GENERAL PROVISIONS

21A.1 Scope

21A.3 Failures, malfunctions and defects

21A.3B Airworthiness directives.

21A.4 Coordination between design and production





FALHAS, ANOMALIAS E DEFEITOS - 21A.3 Failures, malfunctions and defects

(a) System for Collection, Investigation and Analysis of Data.

Possuidores */ de TC, STC e ETSO deverão ter um sistema de recolha, investigação e análise de informação relativa a falhas, mau funcionamento, defeitos ou outras ocorrências com impacto na aeronavegabilidade continuidade.**

Implicações desta exigência:

Existência nos detentores da actividade de projecto (e fabrico) de um sistema do tipo FRACAS (Failure reporting, analysis and corrective action system) que conjugará com outros FMEA (failure mode and effect analysis associados ao cálculo) e FMECA (failure mode, effect and criticality analysis) que capte e analise as ocorrências com impacto na aeronavegabilidade continuada (JAR 25 Appêndice H).

O reporte poderá fazer-se de forma directa para os operadores ou indirecta que é o mais corrente através de Directivas Técnicas (Service Bulletins, Service Letters, etc) categorizados segundo determinadas normas (Flight Safety, Reliability, etc) onde se descreve situações específicas e se apontam as medidas a seguir pelos operadores.

The holder of a Type-Certificate (*), restricted type-certificate, Supplemental Type-Certificate **, European Technical Standard Order (ETSO) authorisation, major Repair Design Approval or any other relevant approval deemed to have been issued under this Regulation **SHALL HAVE A SYSTEM FOR COLLECTING, INVESTIGATING AND ANALYSING REPORTS OF AND INFORMATION RELATED TO FAILURES, MALFUNCTIONS, DEFECTS OR OTHER OCCURRENCES WHICH CAUSE OR MIGHT CAUSE ADVERSE EFFECTS ON THE CONTINUING AIRWORTHINESS** of the product, part or appliance covered by the type-certificate, restricted type-certificate, supplemental type-certificate, ETSO authorisation, major repair design approval or any other relevant approval deemed to have been issued under this Regulation.

INFORMATION ABOUT THIS SYSTEM SHALL BE MADE AVAILABLE TO ALL KNOWN OPERATORS OF THE PRODUCT, PART OR APPLIANCE and, on request, to any person authorised under other associated implementing Regulations.

* Airbus, EADS CASA, Eurocopter, etc

** BAE systems A310 conversion to cargo



21A.4 Coordination between design and production

Each holder of a type-certificate, restricted type-certificate, supplemental type-certificate, ETSO authorisation, approval of a change to type design or approval of a repair design, shall collaborate with the production organisation as necessary to ensure:

- (a) The satisfactory coordination of design and production required by 21A.122 or 21A.133 or 21A.165(c)(2) as appropriate,
- and
- (b) The proper support of the continued airworthiness of the product, part or appliance.

SUBPART G — PRODUCTION ORGANISATION APPROVAL

21A.139 Quality System

- (a) The production organisation shall demonstrate that it has established and is able to maintain a quality system. The quality system shall be documented. This quality system shall be such as to enable the organisation to ensure that each product, part or appliance produced by the organisation or by its partners, or supplied from or subcontracted to outside parties, conforms to the applicable design data and is in condition for safe operation, and thus exercise the privileges set forth in 21A.163.



21A.139 Quality System

1. As applicable within the scope of approval, control procedures for:
 1. Document issue, approval, or change.
 2. Vendor and subcontractor assessment audit and control.
 3. Verification that incoming products, parts, materials, and equipment, including items supplied new or used by buyers of products, are as specified in the applicable design data.
 5. Identification and traceability.
 6. Manufacturing processes.
 7. Inspection and testing, including production flight tests.
 8. Calibration of tools, jigs, and test equipment.
 9. Non conforming item control.
 10. Airworthiness coordination with the applicant for, or holder of, the design approval.
 11. Records completion and retention.
 12. Personnel competence and qualification.
 13. Issue of airworthiness release documents.
 14. Handling, storage and packing.
 15. Internal quality audits and resulting corrective actions.
 16. Work within the terms of approval performed at any location other than the approved facilities.
 17. Work carried out after completion of production but prior to delivery, to maintain the aircraft in a condition for safe operation.

The control procedures need to include specific provisions for any critical parts.

2. An independent quality assurance function to monitor compliance with, and adequacy of, the documented procedures of the quality system. This monitoring shall include a feedback system an account manager ... to ensure, as necessary, corrective action.



21A.143 Exposition

(a) The organisation shall submit to the Competent Authority a production organisation exposition providing the following information:

1. A statement signed by the accountable manager confirming that the production organisation exposition and any associated manuals which define the approved organisation's compliance with this Subpart will be complied with at all times.
2. The title(s) and names of managers accepted by the Competent Authority
3. The duties and responsibilities of the manager(s) including matters on which they may deal directly with the Competent Authority on behalf of the organisation.
4. An organisational chart showing associated chains of responsibility of the managers
5. A list of certifying staff
6. A general description of man-power resources.
7. A general description of the facilities located at each address specified in the production organisation's certificate of approval.
8. A general description of the production organisation's scope of work relevant to the terms of approval.
9. The procedure for the notification of organisational changes to the Competent Authority.
10. The amendment procedure for the production organisation exposition.
11. A description of the quality system and the procedures
12. A list of ...outside parties ...

(b) The production organisation exposition shall be amended as necessary to remain an up-to-date description of the organisation, and copies of any amendments shall be supplied to the Competent Authority.



21A.165 Obligations of the holder

The holder of a production organisation approval shall:

- (a) Ensure that the **production organisation exposition** furnished in accordance with 21A.143 and the documents to which it refers, are used as basic working documents within the organisation.
- (b) **Maintain the production organisation** in conformity with the data and procedures approved for the production organisation approval.
- (c):
 - 1.
 - 2. Determine that other products, parts or appliances are complete and conform to the approved design data and **are in condition for safe operation before issuing EASA Form 1 to certify airworthiness**, and additionally in case of engines, determine according to data provided by the engine type-certificate holder that each completed engine is in compliance with the applicable emissions requirements current at the date of manufacture of the engine, to certify emissions compliance, or
 - 3. Determine that other products, parts or appliances conform to the applicable data before issuing **EASA Form 1 as a conformity certificate**;
- (d) **Record** all details of work carried out.

21A.165 Obligations of the holder

The holder of a production organisation approval shall:

- (e) Establish and **maintain an internal occurrence reporting system** in the interest of safety, to enable the collection and assessment of occurrence reports in order to identify adverse trends or to address deficiencies, and to extract reportable occurrences. This system shall include evaluation of relevant information relating to occurrences and the promulgation of related information.
- (f):
 1. **Report to the holder of the type-certificate** or design approval, all cases where products, parts or appliances have been released by the production organisation and subsequently identified to have possible deviations from the applicable design data, and investigate with the holder of the type-certificate or design approval in order to identify those deviations which could lead to an unsafe condition.
 2.
 3. Where the holder of the production organisation approval is acting as a supplier to another production organisation, **report also to that other organisation all** cases where it has released products, parts or appliances to that organisation and subsequently identified them to have possible deviations from the applicable design data.



21A.165 Obligations of the holder

The holder of a production organisation approval shall:

- (g) **Provide assistance to the holder of the type-certificate** or design approval in dealing with any continuing airworthiness actions that are related to the products parts or appliances that have been produced.
- (h) **Establish an archiving system** incorporating requirements imposed on its partners, suppliers and subcontractors, ensuring conservation of the data used to justify conformity of the products, parts or appliances. Such data shall be held at the disposal of the Competent Authority and be retained in order to provide the information necessary to ensure the continuing airworthiness of the products, parts or appliances.

SUBPART K — PARTS AND APPLIANCES

21A.301 Scope

....

21A.303 Compliance with applicable requirements

....

21A.305 Approval of parts and appliances

.....

21A.307 Release of parts and appliances for installation

No part or appliance (except a standard part), shall be eligible for installation in a type-certificated product unless it is:

- (a) Accompanied by an authorised release certificate (EASA Form 1), certifying airworthiness; and
- (b) Marked in accordance with Subpart Q.



SUBPART Q — IDENTIFICATION OF PRODUCTS, PARTS AND APPLIANCES

21A.801 Identification of products

(a) The identification of products shall include the following information:

1. Manufacturer's name.
2. Product designation.
3. Manufacturer's Serial number.
4. Any other information the Agency finds appropriate.

(b) Any natural or legal person that manufactures an aircraft or engine ... shall identify that aircraft or engine by means of a fireproof plate that has the information specified in paragraph (a) marked on it by etching, stamping, engraving, or other approved method of fireproof marking. The identification plate shall be secured in such a manner that it is accessible and legible, and will not likely be defaced or removed during normal service, or lost or destroyed in an accident.

(c) Any natural or legal person that manufactures a propeller, propeller blade, or propeller hub .. shall identify it by means of a plate, stamping, engraving, etching or other approved method of fireproof identification that is placed on it on a non-critical surface, contains the information specified in paragraph (a), and will not likely be defaced or removed during normal service or lost or destroyed in an accident.

(d) For manned free balloons, the identification plate prescribed in paragraph (b) shall be secured to the balloon envelope and shall be located, if practicable, where it is legible to the operator when the balloon is inflated. In addition, the basket and any heater assembly shall be permanently and legibly marked with the manufacturer's name, part number, or equivalent, and serial number, or equivalent.



SUBPART Q — IDENTIFICATION OF PRODUCTS, PARTS AND APPLIANCES

21A.803 Handling of identification data

- (a) No person shall remove, change, or place identification information referred to in 21A.801(a) on any aircraft, engine, propeller, propeller blade, or propeller hub, or in on an APU, without the approval of the Agency.
- (b) ...
- (c) By way of derogation from paragraphs (a) and (b), any natural or legal person performing maintenance work under the applicable associated implementing rules may, in accordance with methods, techniques and practices established by the Agency:
 - 1. Remove, change, or place the identification information referred to in 21A.801(a) on any aircraft, engine, propeller, propeller blade, or propeller hub, or on an APU; or
 - 2. Remove an identification plate for an APU, when necessary during maintenance operations.
- (d) No person shall install an identification plate removed in accordance with subparagraph (c)(2) on any aircraft, engine, propeller, propeller blade, or propeller hub other than the one from which it was removed.

21A.804 Identification of parts and appliances

- (a) Each manufacturer of a part or appliance shall permanently and legibly mark the part or appliance with:
 - 1. a name, trademark, or symbol identifying the manufacturer; and
 - 2. the part number, as defined in the applicable design data; and
 - 3. the letters EPA (European Part Approval) for parts or appliances produced in accordance with approved design data not belonging to the type-certificate holder of the related product, except for ETSO articles.
- (b) By way of derogation from paragraph (a), if the Agency agrees that a part or appliance is too small or that it is otherwise impractical to mark a part or appliance with any of the information required by paragraph (a), the authorised release document accompanying the part or appliance or its container shall include the information that could not be marked on the part.



SUBPART Q — IDENTIFICATION OF PRODUCTS, PARTS AND APPLIANCES

21A.805 Identification of critical parts

In addition to the requirement of 21A.804, each manufacturer of a part to be fitted on a type-certificated product which has been identified as a critical part shall permanently and legibly mark that part with a part number and a serial number.

21A.807 Identification of ETSO articles

- (a) Each holder of an ETSO authorisation ... shall permanently and legibly mark each article with the following information:
1. The name and address of the manufacturer;
 2. The name, type, part number or model designation of the article;
 3. The serial number or the date of manufacture of the article or both; and
 4. The applicable ETSO number.
- (b) **By way of derogation** from paragraph (a), if the Agency agrees that a part is too small or that it is otherwise impractical to mark a part with any of the information required by paragraph (a), the authorised release document accompanying the part or its container shall include the information that could not be marked on the part.
- (c) Each person who manufactures an APU ... shall identify that APU by means **of a fireproof plate** that has the information specified in paragraph (a) marked on it by etching, stamping, engraving, or other approved method of fireproof marking. The identification plate shall be secured in such a manner that it is accessible and legible, and will not likely be defaced or removed during normal service, or lost or destroyed in an accident.



SUBPART M – REPAIRS

21A.431 Scope

- (a) This Subpart establishes the procedure for the approval of repair design, and establishes the rights and obligations of the applicants for, and holders of, those approvals.
- (b) A **'repair'** means elimination of damage and/or restoration to an airworthy condition following initial release into service by the manufacturer of any product, part or appliance.
- (c) **Elimination of damage by replacement of parts** or appliances without the necessity for design activity shall be considered as a maintenance task and shall therefore require no approval under this Part.
- (d) A repair to an ETSO article shall be treated as a change to the ETSO design

21A.432 Eligibility

- (a) Any natural or legal person that has demonstrated, or is in the process of demonstrating, its capability under 21A.432 B shall be eligible as an applicant for a major repair design approval under the conditions laid down in this Subpart.
- (b) Any natural or legal person shall be eligible to apply for approval of a minor repair design.

21A.432B Demonstration of capability

- (a) An applicant for a major repair design approval shall demonstrate its capability by holding a **design organisation approval**,
....
- (b) **By way of derogation** from paragraph (a), as an alternative procedure to demonstrate its capability, an applicant may seek Agency agreement for the use of procedures setting out the specific design practices, resources and sequence of activities necessary to comply with this Subpart.



SUBPART M – REPAIRS

21A.433 Repair design

(a) The applicant for approval of a repair design shall:

1. Show compliance **with the type-certification** basis and environmental protection requirements incorporated by reference in the type-certificate or supplemental type-certificate, as applicable, or those in effect on the date of application (for repair design approval), plus any amendments to those certification specifications or special conditions the Agency finds necessary to establish a level of safety equal to that established by the type-certification basis incorporated by reference in the type-certificate or supplemental type-certificate.
2. Submit all necessary substantiation data, when requested by the Agency.
3. Declare compliance with the certification specifications and environmental protection requirements of subparagraph (a)(1).

(b) **Where the applicant is not the type-certificate or supplemental type-certificate holder**, as applicable, the applicant may comply with the requirements of paragraph (a) through the use of its own resources or through an arrangement with the type-certificate or supplemental type-certificate holder as applicable.

21A.435 Classification of repairs

- (a) A repair may be 'major' or 'minor'. The classification shall be made in accordance with the criteria of 21A.91 for a change in the type design.
- (b) A repair shall be classified 'major' or 'minor' under paragraph (a) either:
1. By the Agency, or
 2. **By an appropriately approved design organisation under a procedure agreed** with the Agency.



SUBPART M – REPAIRS

21A.437 Issue of a repair design approval

When it has been declared and has been shown that the repair design meets the applicable certification specifications and environmental protection requirements of 21A.433(a)(1), it shall be approved:

- (a) by the Agency, or
- (b) by an appropriately approved organisation that is also the type-certificate or the supplemental type-certificate holder, under a procedure agreed with the Agency, or
- (c) for minor repairs only, by an appropriately **approved design organisation** under a procedure agreed with the Agency.

21A.439 Production of repair parts

Parts and appliances to be used for the repair shall be manufactured in accordance with production data based upon all the necessary design data as provided by the repair design approval holder:

- (a) Under Subpart F, or
- (b) By an organisation appropriately approved in accordance with Subpart G, or
- (c) By an **appropriately approved maintenance organisation**.

21A.441 Repair embodiment

- (a) The embodiment of a repair shall be made by an appropriately approved maintenance organisation, or by a production organisation appropriately approved ...
- (b) The design organisation shall transmit to the organisation performing the repair all the necessary installation instructions.



SUBPART M – REPAIRS

21A.443 Limitations

A repair design may be approved subject to limitations, in which case the repair design approval shall include all necessary instructions and limitations. These instructions and limitations shall be transmitted by the repair design approval holder to the operator in accordance with a procedure agreed with the Agency.

21A.445 Unrepaired damage

(a) When a damaged product, part or appliance, is left unrepaired, and is not covered by previously approved data, the evaluation of the damage for its airworthiness consequences may only be made;

1. by the Agency, or
2. by an appropriately **approved design organisation** under a procedure agreed with the Agency. Any necessary limitations shall be processed in accordance with the procedures of 21A.443.

(b) **Where the organisation evaluating the damage under paragraph (a) is neither the Agency nor the type-certificate** or supplemental type-certificate holder, this organisation shall justify that the information on which the evaluation is based is adequate either from its organisation's own resources or through an arrangement with the type-certificate or supplemental type-certificate holder, or manufacturer, as applicable.

21A.447 Record keeping

For each repair, all relevant design information, drawings, test reports, instructions and limitations possibly issued in accordance with 21A.443, justification for classification and evidence of the design approval, shall:

- (a) be held by the repair design approval holder at the disposal of the Agency, and
- (b) be retained by the repair design approval holder in order to provide the information necessary to ensure the continued airworthiness of the repaired products, parts or appliances.



SUBPART M — REPAIRS

21A.449 Instructions for continued airworthiness

- (a) The holder **of the repair design approval** shall furnish at least one complete set of those changes to the instructions for continued airworthiness which result from the design of the repair, comprising descriptive data and accomplishment instructions prepared in accordance with the applicable requirements, to each operator of aircraft incorporating the repair. The repaired product, part or appliance may be released into service before the changes to those instructions have been completed, but this shall be for a limited service period, and in agreement with the Agency. Those changes to the instructions shall be made available on request to any other person required to comply with any of the terms of those changes to the instructions. The availability of some manual or portion of the changes to the instructions for continued airworthiness, dealing with overhaul or other forms of heavy maintenance, may be delayed until after the product has entered into service, but shall be available before any of the products reaches the relevant age or flight — hours/cycles.
- (b) If updates to those changes to the instructions for continued airworthiness are issued by the holder of the repair design approval after the repair has been first approved, these updates shall be furnished to each operator and shall be made available on request to any other person required to comply with any of the terms of those changes to the instructions. **A programme showing how updates to the changes to the instructions for** continued airworthiness are distributed shall be submitted to the Agency.



SISTEMAS DE QUALIDADE vs “built to print”

Tópicos:

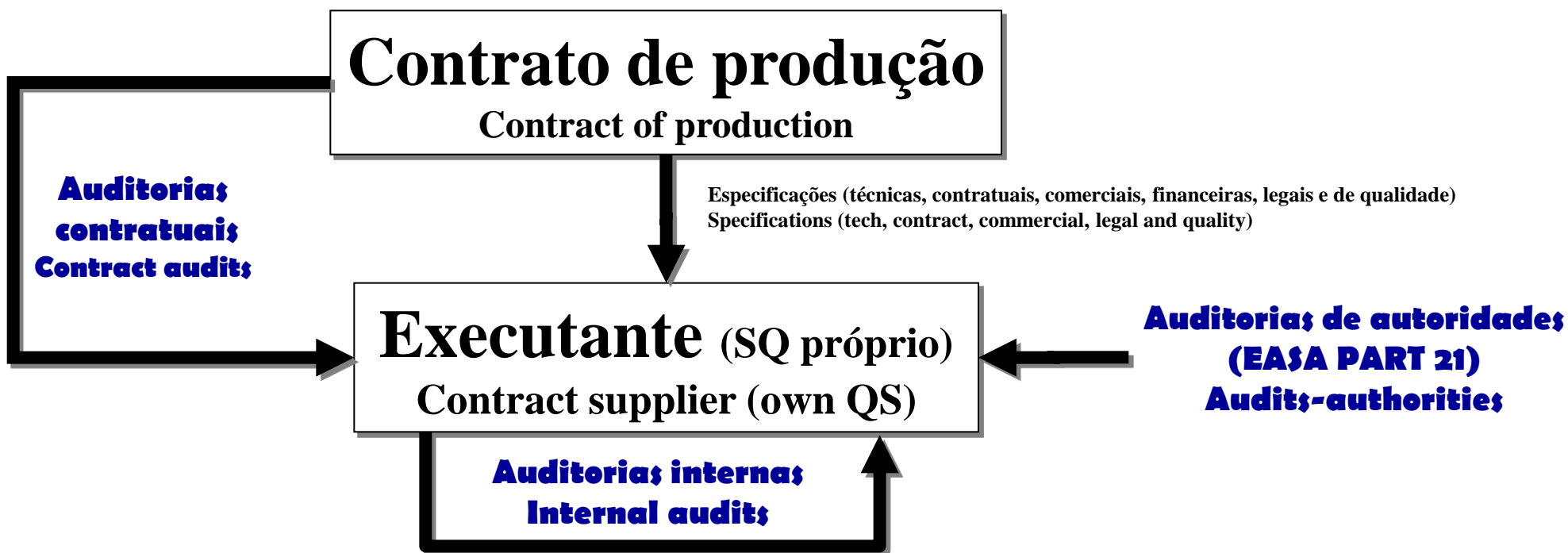
- Modelo geral
- Responsabilidades da gestão de topo
- Revisão ao contrato
- Controlo de (sub)projectos
- Documentação e controlo de dados
- Aquisições-fornecimentos
- Controlo de fornecedores
- Identificação de produtos e rastreabilidade
- Controlo de processos
- Inspeção e testes
- Controlo de EMP
- Controlo de produtos não conformes

Topics:

- General
- top management responsibilities
- Contract revision
- Control of projects
- Documentation & Data control
- Aquisitions- supplies
- Suppliers Control
- Products ID and traceability
- Control of processes
- Inspection & testing
- Control of measuring and precision equipment
- Control of non-conformaties
- Corrective & preventive actions



MODELO GERAL SISTEMA DE QUALIDADE/Quality general model:



RESPONSABILIDADES DA GESTÃO DE TOPO (no SQ):

- Política de qualidade
- Responsabilidade e autoridade (definição)
- Recursos (atribuição)
- Definição de Account manager para o SQ
- Revisão do SQ

Top management responsibilities vs QS

- QS policies
- Definition of responsibilities & authorithies
- Assignment of resources
- Account manager for QS
- QS revisions



REVISÃO AO CONTRATO-Contract Revision

Assim como a regulamentação exige revisão do SQ também, no caso da fabricação BTP se exige programa de revisão do contrato (de aquisição de serviços de fabricação BTP) antes deste ser submetido como proposta.

As SQ is revised also the contract needs to be revised prior its submitance to the contractor.

O objectivo desta actividade é rever, através de metodologia que sistematize e documente, os termos e condições exigidas a um fornecedor relativos a especificações técnicas, contratuais, qualidade, etc, por modo a que a proposta incida sobre todos os elementos requeridos e nada fique de fora.

The objective of such revision is to systematically and document according to the terms and conditions revise and ensure that the supply will meet all specifications.

Terminologia standard associada à formulação de contratos (comercial):

Terminology

- Request for information (RFI)
- Request for quotation (RFQ)
- Inviation to tender
- Invitation to offer
- Best and final offer (BAFO)
- Work Scope
- Statement of work (SOW)
- Work breakdown structure (WBS)
- First Article Inspection (FAI);
- CAD/CAE/CAM/CIM



REVISÃO AO CONTRATO/Contract Revision

Os aspectos que fazem parte da revisão do contrato incidem sobre:

Aspects to be taken in consideration:

- *Workscope* (âmbito da produção);
- Especificações e Standards a usar no processo de fabrico;
 - Specs and standards to be used for the manufacturing processes.
- Requisitos em termos de materiais, produtos e serviços;
 - Materials, products and services requirements.
- Requisitos em termos de inspecção e aceitação (FAI) de produtos manufacturados;
 - FAI criteria
- Requisitos em termos de processos de fabrico.
 - Manufacturing processes requirements

CONTROLO DE (SUB)PROJECTOS/DESIGN CONTROL

Esta componente do SQ em BTP diz respeito ao projecto de estaleiro e ferramentas – já que o projecto (digamos) principal a que se associa um TC, STC ou ETSO é da responsabilidade da entidade contratante. Todavia, para efeitos de controlo de dados e de processos há também exigências em matéria deste tipo de actividade.

This aspects mainly relates to the project of jigs and tools whilts control of main project is under the Contractor responsibility and is related to TC, STC and ETSO.

Terminologia:

Entidade contratante	- » entidade contratada
Entidade subcontratante	-» entidade subcontratada
(Main)Contractor (OEM)	-» Supplier
	-» Vendor
Main contractor	-» contractor/supplier



CONTROLO DE (SUB)PROJECTOS/DESIGN CONTROL

As actividades de projecto abrangem:

The project activities cover:

- ferramentas para produção de peças simples (enformação de chapa- e.g., estiragem, estampagem), enformação de perfis (e.g., cold rolling), materiais compósitos;
Tooling for the production of single parts (sheet metal forming, profiles and composites materials)
- estaleiros de montagem de sub-conjuntos e de conjuntos;
Jigs for sub sets and mains sets assy.
- equipamentos de transporte (actividade interna e externa).
Equipment for transportation from supplier to contractor

O controlo da actividade de projecto cobre (nos termos da regulamentação ISO 9001:2000) os seguintes aspectos:

Within the ISO 9001:2000 regulation the design control covers:

- | | |
|---|--|
| - Planeamento da definição e desenvolvimento do projecto; | Project definition and planning; |
| - Aspectos organizativos e interfaces técnicas; | Organization and technical interfaces; |
| - Inputs para projecto (especificações) | Project input/specs; |
| - Output de projecto (deliverables); | Project deliverables; |
| - Revisões de projecto | Project revisions; |
| - Verificação do projecto; | Project verification; |
| - Validação do projecto; | Project validation; |
| - Alterações ao projecto. | Project changes. |



DOCUMENTAÇÃO E CONTROLO DE DADOS/Documentation & Data control

Princípio base – basic principle:

Os documentos devem ser revistos e aprovados por pessoal autorizado. Um ficheiro mestre (*master file*) deverá existir para permitir o controlo em qualquer instante do estado de revisão de um documento evitando assim o uso de elementos inválidos ou obsoletos.

Documents must be revised and approved by authorised staff. A master file shall exist to allow at any the control of revisions and valid documentation.

Desta forma devem ser identificados e geridos os documentos que pela sua natureza estejam directa ou indirectamente relacionados com a actividade produtiva, salientando-se:

The documents that must identified and controled are:

- | | |
|---|---|
| - políticas; | policies |
| - normas / procedimentos; | procedures and norms |
| - desenhos; | drawings (also knows and blue prints or BP) |
| - relatórios específicos; | specific reports |
| - instruções para a produção; | production instructions |
| - processos de aquisição; | aquisition processes |
| - contratos; | contracts |
| - planos (produtivos, engenharia, logística). | Plans (productive, engineering, logistics) |

O controlo documental envolve a referenciação adequada de documentos bem como ainda o controlo de distribuição e alterações

Control of documents includes ref and control of distribution and changes.



CONTROLO DAS AQUISIÇÕES /Fornecimentos/Aquisitions/supplies QC

3 aspectos prevalecem na perspectiva do SQ – 3 aspects prevail at the of QS:

- avaliação de fornecedores/suppliers assessment;
- controlo de dados de aquisições/fornecimentos/control of acquisition/supply data;
- verificação dos produtos/serviços adquiridos/product & services verification;

AVALIAÇÃO DE FORNECEDORES – Suppliers assessment:

- fornecedores autorizados/authorised suppliers by the Contractor;
- qualificação de fornecedores/suppliers qualification process;
- lista de fornecedores autorizados/approved suppliers list;
- critérios de avaliação de fornecedores/suppliers assessment criteria;
- auditorias/audits;

-CONTROLO DE DADOS DE AQUISIÇÕES/FORNECIMENTOS/control of acquisition/supply data;

A legislação não estabelece (naturalmente) o que é uma encomenda de material deve conter. Contudo exige pelo seu lado que os produtos fornecidos cumpram a respectiva especificação (e ainda que todo o processo esteja documentado). Desta forma o processo aquisitivo para garantir os 2 aspectos anteriores deverá assegurar informação relativa aos seguintes aspectos:

The regulations to not establish the specific content of a material order. However it requires that supplied product meet (their) specifications as well as all process needs to be documented. As such to comply with those 2 objectives an acquisition must ensure at least:

- identificação dos artigos (produtos/serviços)/ID of products and services;
 - nomenclatura, PN, SN, Lote
- qtd/qty;
- especificação de matérias/spec;
- procedimentos e cuidados de transporte e manuseamento/transport and handling procedures;
- critérios de verificação/aceitação/Verification and acceptance criteria.



CONTROLO DAS AQUISIÇÕES /Fornecimentos/Aquisitions/supplies QC

Artigos e serviços fornecidos pela entidade contratante são normalmente designados de:

Articles and serviced supplied by the contractor are normally known as:

BFM - Buyer Furnished Equipment

CFE - Customer Furnished Equipmment

GFE - Government Furnished Equipment

BFM - Buyer Furnished Material

CFM - Customer Furnished Material

GFM - Government Furnished Material

Estes artigos independentemente da origem são controlados, normalmente em termos documentais, todavia não impede em termos legais que a entidade que os incorporará no produto final não faça as verificações e testes que forem adequados à respectiva especificação, uma vez que a responsabilidade final recai na entidade que produz o artigo.

These articles regardless their origin are controlled through documentation, however from a legal perspective nothing prevents the manufacturer to carry on the verifications and test according to the applicable spec, as the final responsibility lies on the suppliers side.



CONTROLO DAS AQUISIÇÕES /Fornecimentos/Aquisitions/supplies QC

O controlo de artigos fornecidos para incorporar na produção inclui, entre outras verificações e testes o seguinte:

The control of incoming articles to be incorporated in the production process includes among other the following verification and tests:

- documental para comprovar a especificação do produto fornecido bem como validade (se aplicável);**
 - Document control to check product spec and validity.**
- IND – (Inspeções Não Destrutivas) que podem abranger testes de características químicas, mecânicas (e.g., dureza), etc**
 - Non Destructive Inspections (NDI) covering chemical and mechanical properties (e.g., hardness).**
- Inspeções destrutivas – testes metalográficos, de características mecânicas do material.**
 - Destructive testing – metalographic, mechanical characteristics.**
- Funcionais para o caso de equipamentos**
 - Functional testing for equipments.**

IDENTIFICAÇÃO & RASTREABILIDADE / Parts ID & traceability

Todos os artigos fabricados devem ser identificados. No caso de produção sob contratação, as peças serão identificadas de acordo as regras pré-definidas pelo main contractor. A definição do algoritmo como as peças serão identificadas é da responsabilidade do main contractor – usando ATA 100 SPEC, ou outra metodologia AECMA 1000D, MIL-STF-1808, etc. Em termos tecnológicos, as peças serão identificadas preferencialmente por gravação (mecânica, química) ou por tinta.

All manufactured items must be duly identified. In the case of the production BTP, the parts are to be identified accordingly to the rules defined by the main contractor, normally using ATA 100 SPEC, AECMA 1000D, MIL-STD-1808 or other similar way. In technological terms, parts shall be preferably identified using etching processes (mechanical, chemical) or painted.



Rastreabilidade: todas as peças (conjuntos e subconjuntos) serão rastreáveis em termos processo, de produtos e de matérias empregues no respectivo fabrico. Isto significa que toda a actividade associada deverá estar complementada documentada, sendo possível em qualquer momento do processo de fabrico e mesmo posteriormente, identificar quem fez, como fez, quando fez e quem aprovou .

Traceability: all parts (main assys and sub-assys) are traceable in terms of processes, products and raw materials used in the production activity. This means that activity needs to be fully documented, being possible at any time to identify who, how and when made it as well as who approved it.

CONTROLO DE PROCESSOS / Control of processes

O controlo de processos pode ser entendido de 2 formas, uma relacionada com a sua formulação e rastreabilidade. Outra que exige, para além destes 2 aspectos, prévia homologação e contínuo controlo. Esses processos são considerados “Processos Especiais”, sendo exemplos:

The control of processes can be seen in 2 ways, one related to its formulation and rastreability; the other requires, in addition to these aspects, previous certification and continuous control. These processes are considered “special processes”, being examples:

- Soldadura/welding;
- Pintura/painting;
- Tratamentos térmico/heat treatment;
- Tratamentos electrolíticos (galvanoplastia e deposição química)/Galvanic and electroless processes.

(Mais processos especiais existem, designadamente no domínio dos END).

(Other special processes exist, namely NDI).



INSPECÇÃO E TESTES / Inspection and testing

A aceitação de produtos manufacturados envolve 4 etapas, a saber:

The acceptance of manufactured items encompasses 4 stages, that is:

- Inspecção e testes de recepção de materiais, produtos e serviços/peças (subcontratados);**
Incoming inspection;
- Inspecção durante a realização produtiva;**
In-process inspection;
- Inspecção final e testes;**
Final inspection and testing;
- Registos de inspecção e de testes.**
Inspection and tests records

-INSPECÇÃO E TESTES DE RECEPÇÃO DE MATERIAIS, PRODUTOS E SERVIÇOS/PEÇAS (SUBCONTRATADOS) **Incoming inspection**

A avaliação à recepção dos artigos tem 2 vertentes, documental e de testes.

A documental envolve a confirmação em como os artigos entregues cumprem com a especificação associada ao processo de encomenda/aquisição.

A componente de testes envolve a realização de verificações de condição (por amostragem ou a 100%) dos artigos fornecidos:

- validade;**
- em termos visuais, químicos, mecânicos.**

The incoming inspection includes two aspects: document and testing.

The document evaluation includes confirmation that all items supplied meet the specification defined in the order.

The testing encompasses visual, mechanical and/or chemical verification of the products.



Durante a fase de produção inspecções deverão ser realizadas em momentos que permitam comparar a conformidade da peças/conjunto com as especificações. As inspecções podem ser delegadas, sendo realizadas por pessoal devidamente qualificado. O mesmo se aplica aos processos de fabrico que, para o caso dos especiais, também devem ser certificados, para garantir que permitem produzir peças que cumpram com as especificações.

During the production phase at defined points parts/sets inspections must be carried out to verify that personel and processes meet the applicable specifications.

De forma geral, um plano efectivo de inspecção durante a fase produtiva é aquele que:

- I- assegura a selecção de adequados métodos de inspecção
 - » não destrutivos [visual, medição (características geométricas), ultra-sons, RX, correntes induzidas, partículas magnéticas, etc]
 - » destrutivos (metalográficos, ensaios mecânicos, adesão, etc).**
- II- garante no caso de adoptarem métodos de controlo estatísticos, em caso de falha de peças pertencentes o lote abrangido, não ocorrerão falhas catastróficas (para a aeronave ou motor);**
- III- que inclui inspecções realizadas e planeadas em pontos do processo produtivo, sendo eficazes por modo a garantir que os elementos produzidos cumprem com as respectivas especificações;**
- IV- verifica e confirma a existência de áreas de produção devidamente organizadas e segregadas, evitando que possa ocorrer interferência negativas inter-processos (pintura vs maquinaria vs tratamentos electrolíticos).**

In general terms, an effective inspection plan during the production stage is the one that:

- I - ensures selection of adequate methods (non-destructive:visual, measurements, ultra-sound, RX, eddy currents, magnetic particles, etc; destructive:metallographic, mechanical testing, adhesion, etc);**
- II –ensures that in case statistical control processes are used non-conformities of parts belonging to the applicable lot do not correspond to a catastrophic failure (a/c or engine);**
- III-includes efficient control at predefined points of the production allow parts to meet specification;**
- IV-ensures appropriate organization of the production with processes duly segregated to avoid negative interference (painting vs machining)**



-INSPECÇÃO FINAL E TESTES

Final inspection and tests

Os testes finais distinguem-se dos realizados durante a fase produtiva, uma vez que são feitos baseados num plano de Qualidade e de Testes específicos que abrangem o conjunto completo.

No caso de testes a aeronaves completas inclui naturalmente testes funcionais e voos de ensaio. No caso de se tratar de fabricar o que se designa por “*green aircraft*”, isto é, somente a montagem da estrutura faltando interiores, realizam-se testes apropriados, e.g., pressurização da fuselagem, estanqueidade de depósitos, etc.

O resultado final é completado com a emissão de um certificado tipo EASA FORM 1.

The final tests are different from those carried out during the production phase, because they are based on a Quality Plan as well as they are based on a specific test plan which covers the complete system.

In the case of complete a/c final tests include functional and flight tests. In case a green a/c is built up, i.e., fuselage assembly without interiors and engines, etc, appropriate tests are carried out namely fuselage pressurisation, fuel tank tests, etc.

Final results are completed with the issuance of a certificate similar to EASA PART 1.

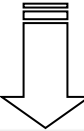
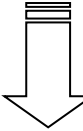
- REGISTOS DE INSPECÇÃO E DE TESTES.

Inspection and tests records

Componente essencial do processo é o registo da respectiva actividade – obrigatoriedade regulamentar para garantir a rastreabilidade de todos os actos associados. Para isso impressos devem ser definidos.

An essential component of the process is the registration of tests – this is a mandatory activity resulting from regulations to ensure traceability of all acts related – which is carried out using appropriate forms.



1. Approving Competent Authority/Country		AUTHORISED RELEASE CERTIFICATE EASA FORM 1				3. Form Tracking Number	
4. Approved Organisation Name and Address:						5. Work Order/Contract/Invoice	
6. Item	7. Description	8. Part No	9. Eligibility (*)	10. Quantity	11. Serial/Batch No	12. Status/Work	
13. Remarks Part M Section A Subpart F organisation approval number: AAA RRR XXXX							
<div style="display: flex; justify-content: space-around; align-items: center;"><div style="text-align: center;"></div><div style="text-align: center;"></div></div>							
14. Certifies that the items identified above were manufactured in conformity to: <input type="checkbox"/> approved design data and are in condition for safe operation <input type="checkbox"/> non-approved design data specified in block 13				19. <input type="checkbox"/> Part-145.A.50 Release to Service <input type="checkbox"/> Other regulation specified in block 13 Certifies that unless otherwise specified in block 13, the work identified in block 12 and described in block 13, was accomplished in accordance with Part-145 and in respect to that work the items are considered ready for release to service.			
15. Authorised Signature		16. Approval/ Authorisation Number		20. Authorised Signature		21. Certificate/Approval Ref. No	
17. Name		18. Date (d/m/y)		22. Name		23. Date (d/m/y)	



Control of inspection, measuring and test equipment

As entidades fabricantes deve estabelecer e manter de forma documentada procedimentos para controlo, calibrar todos os equipamentos incluindo software utilizados para inspeccionar, medir, testar as actividades produtivas que se trate de peças simples quer formação de sub-conjuntos e conjuntos.

The manufacturing entities shall ensure in a duly documented way all aspects related to the calibration and its control of all hardware and software to carry on inspection, measuring and testing of single parts as well as sub and major assy .

Itens sob controlo/itens to control:

- Equipamentos de medida e teste: para garantir que estão permanentemente calibrados ou que no caso do software mantém as especificações para que foi concebido;**
Measuring and testing equipment: to ensure that they are permanently calibrated and in the case of the software that it keeps its specifications;
- Ferramentas de fabrico: para verificar integridade estrutural e dimensional assegurando que as peças manufacturadas cumprem com as respectivas especificações;**
Manufacturing tools: to ensure its structural and dimensional integrity in order to make sure parts manufactured comply with the specifications;
- Estaleiros de montagem: para verificar integridade estrutural e dimensional que os componentes formados cumprem com as respectivas especificações.**
Jigs: to ensure its structural and dimensional integrity in order to make sure sub and major assys comply with the specifications



Control of inspection, measuring and test equipment

EQUIPAMENTOS DE MEDIDA E PRECISÃO Inspection, measuring and testing equipment	FERRAMENTAS DE PRODUÇÃO Manufacturing tooling	ESTALEIROS Jigs
Micrómetros - micrometer Multímetros – multimeters Pressão – pressure gauges Temperatura - thermometer Comparadores - gauges Calibres “Go-No Go” Chaves de aperto; torque wrenches Software Teodolitos ...	Compósitos - composites Quinadeiras - punching Estampagem– pressing; Estiragem – stretching; Tratamentos térmicos – Heat treatment <i>Cold rolling</i> <i>Hydroforming</i> ...	Estaleiros de montagem – assy jigs Estaleiros de fabrico – montagem Manufacturing jigs



-CONTROLO DE PRODUTOS NÃO CONFORMES

-Control of non-conformities

São peças (produtos/serviços) não-conformes as que não estejam de acordo com as especificações.

Devem ser segregadas e colocadas devidamente identificadas em local próprio.

Any part (products/services) that does not meet specifications is a non-conformity. Need to be segregated and placed in a dedicated location.

Material Review Board:

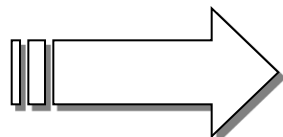
Grupo que tem por objectivo avaliar as não-conformidades, propor, aprovar e seguir as resoluções aprovadas.

Group aiming to assess the non-conformities, propose, approve and follow up the solutions defined.

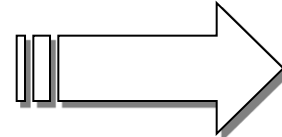


PROCESSO DE FABRICAÇÃO MANUFACTURING PROCESS

Pré-industrialização *Pre-industrialisation*



Industrialização *Industrialisation*



Produção série *Series production*

1. Orçamentação (valoração industrial)

Budgeting

- Tempos, materiais, serviços e prazos

Time-Material, Services and Turn around time (TAT)

- Paramétrica/parametrics
- Analítica/analytical
- Mista/mix

2. Planeamento da produção/Production Planning

3. Avaliação económica/Economical feasibility

4. Preparação da oferta/Preparation of offer

5. Contrato/negociações/contract/negotiations

1. Componente Técnica estruturante

Structuring technical component

- Estrutura do Produto Engenharia

① Product Breakdown Structure

- Estrutura do produto fabricação

② Manufacturing breakdown Structure

- Processos Especiais

③ Special Processes

- Tempos e métodos

④ Methods

2. Componente logística/Logistic Component

- Programa de aquisições

Acquisition programme

- Aquisições/Acquisitions

3. Componente produtiva

Production Operations Component

⑤ Ferramentas/Tooling

Estaleiros/Jigs ⑥

⑦ Pré-série/protótipo|Pre-series/Prototype

4. Componente Qualidade (FAI)

Quality Component

⑧

1. Suporte Técnico Continuado

Continued technical Support

2. Componente logística/

Logistic Component

3. Componente produtiva/Oper.

Production Operations Component

4. Componente Qualidade (FAI)

Quality Component

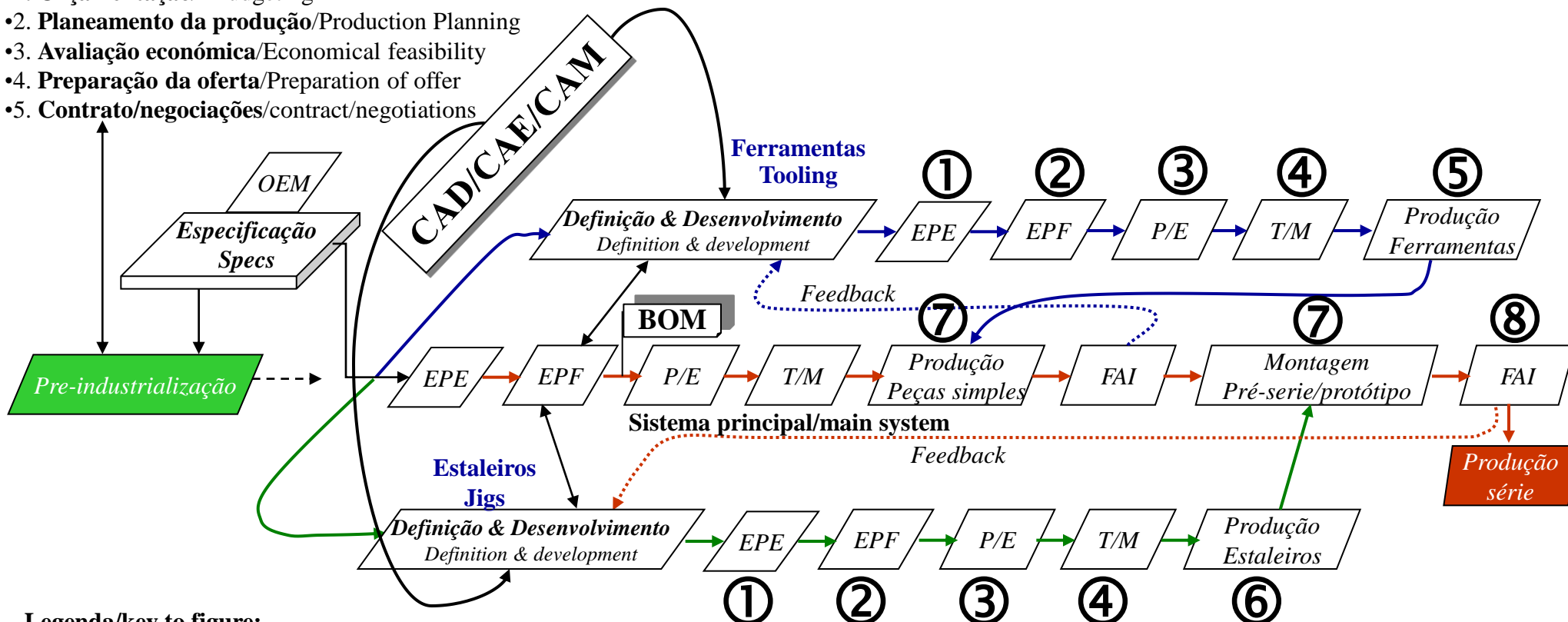
Programas especiais:

Special programmes

- redução de custos/cost reduction
- redução de tempos/time reduction;



1. Orçamentação/ Budgeting
2. Planeamento da produção/Production Planning
3. Avaliação económica/Economical feasibility
4. Preparação da oferta/Preparation of offer
5. Contrato/negociações/contract/negotiations



Legenda/key to figure:

- | | |
|---|---|
| EPE – Estrutura do Produto Engenharia –
Product breakdown Structure | Inclui a cascata do sistema (ATA 100) para permitir criar a BOM (especificações, materiais, etc)
Includes BOM; |
| EPF – Estrutura do Produto Fabrico –
Manufacturing Breakdown Structure | Inclui o layout da montagem, ferramentas/Includes layout of production and manufacturing
processes selection |
| P/E – Processos Especiais –
Special Processes | Inclui Tratamentos Térmicos, Tratamentos electrolíticos, Pintura, END
Includes Special Processes certification (HT, Plating, coating, NDI) |
| T/M – Tempos e Métodos –
Methods | Inclui a definição de opções de fabrico e de montagem, estimativa e controlo de tempos de produção
Includes methods (job cards, resources) |

OE M - Original Equipment Manufacturer



ACTIVIDADES

Activities

ENGENHARIA/Engineering

**Conceber e desenvolver ferramentas de produção;
Define and develop production tooling;**

Estruturar, do ponto de vista técnico, a actividade produtiva assegurando o cumprimento das especificações de projecto.

To structure from a technical perspective all production activity in accordance the specifications

Suportar as actividade produtivas na fase de produção série (modificações e melhorias de processo)

To support the production series (modifications and process improvement);

Gerir a configuração do produto – Product Configuration Management;

Gerir a configuração do fabrico – Manufacturing control managment.

QUALIDADE/Quality

Assegurar que a manufactura cumpre requisitos de qualidade, definidos em regulamentação adequada, normas de qualidade tipo JAR 21/EASA PART 21, FAR 21, e em documentos contratuais específicos.

To ensure that manufacturing complies with project and with JAR21/EASA PART 21, FAR 21 regulations and contractual arrangements.

PLANEAMENTO E CONTROLO/Planning and Control

Assegurar que a manufactura dos componentes e dos sistemas aeronáuticos cumpre a programação previamente definida para o efeito (calendário);

To ensure that manufacturing process complies with the schedule.



ACTIVIDADES **Activities**

GESTÃO/Management

Administrar adequadamente o Programa de Industrialização e fabrico série garantindo o cumprimento de Prazos, Preço e Qualidade.

To manage the industrialisation and production series process ensuring prices, quality and schedule.

PRODUÇÃO (OPERAÇÕES)/Production (Operations)

Manufacturar os componentes e os sistemas aeronáuticos objecto do programa de industrialização da produção série, garantindo o cumprimento de Prazos, Preço e Qualidade.

To Manufacture the components and and aeronautical systems related to the industrialization and series production.

LOGÍSTICA /logistics

Garantir o funcionamento em tempo de matéria-prima e demais itens necessários à manufactura, incluindo gestão de stocks, armazéns e fornecimento de matéria prima, produtos e serviços.

To ensure the supply (procure and acquire) including stock and warehouse management as well as supply raw material, products and services.

ACTIVIDADES ESPECÍFICAS DO PROCESSO DE INDUSTRIALIZAÇÃO/ **Specific activities of industrialisation**

No âmbito da Engenharia/Engineering

Sub-grupo Projecto de Ferramentas/Tooling project sub group

Conceber, desenvolver e aprovar as ferramentas necessárias à produção de peças simples, montagem de sub-conjuntos e conjunto final.

Design, develop and approve all tooling and jigs require to production



ENGENHARIA DE PROCESSO/Process Engineering

- **Definição da Estrutura do Produto Engenharia – To structure the PBS**
- **Cascata/tree;**
- **Componentes (referenciação/nomenclatura)/Components ref/nomenclature;**
- **Especificação de materiais, acabamentos, testes de aceitação, normas/materials specifications, finishings, acceptance testing;**
- **Desenhos aplicáveis/drawings;**
- **Quantidades/Qtys**
- **Especificações de qualidade/quality requirements;**
- **Especificações de fornecedores/Supplier requirements.**

DEFINIÇÃO DA ESTRUTURA DO PRODUTO FABRICO/Production layout definition:

- **Layout produtivo – manufacturing sequence;**
- **Opções de subcontratação – subcontracting options;**
- **Transporte/transportation**

DEFINIÇÃO DOS PROCESSOS ESPECIAIS/ Special processes;

- **Estruturar os processos especiais/ To define and structure;**
- **Testar os processos especiais/Test special processes;**
- **Submeter a aprovação da qualidade/To submit to quality for approval.**

DEFINIÇÃO DE TEMPOS E MÉTODOS – Methods:

- **Preparar documentos produtivos/To establish all production documents**
- **Sequência produtiva/manufacturing sequence (job cards/routing);**
- **Controlo de qualidade/Quality control;**
- **Materiais a usar/materials to be used;**
- **Tempos produtivos (set up, produção)/Production times (set up/operating);**
- **Curva de aprendizagem /learning curve;**
- **Programação CNC e simulação / CNC programming and simulation;**
- **Controlo de tempos e de processos reais (process and time control)**



QUALIDADE /Quality

- **Certificação e homologação de Processos Especiais/Certification of Special Processes;**
- **Inspecção do Primeiro Artigo, vulgo FAI/FAI;**
- **Estabelecimento e implementação da metodologia da garantia de qualidade do processo de fabrico/Quality methods and processes;**
- **Controlo de qualidade; Quality control during process**
- **Assegurar o cumprimento dos requisitos da natureza técnica, contratual e outros/To ensure compliance with all requirements.**

PLANEAMENTO E CONTROLO DAS OPERAÇÕES /P&L of Operations

Calendarizar e controlar as actividades/schedule all activities:

- **Produção de ferramentas, estaleiros, fabricação de peças simples e montagem de pré-série/protótipo;
Manufacturing of tooling, jigs, single parts and pre-series/prototype;**
- **Programa de Qualidade associado aos processos especiais e FAI/Quality programme of special processes and FAI;**
- **Logística em termos de lançamento de programa de aquisições/procurement and acquisition programme.**

GESTÃO/Management

Estabelecer/Establish :

- **WBS/work breakdown structure;**
- **Responsibilities;**
- **Master schedule milestones, reviews and audits;**
- **Make or buy policies;**
- **Objectivos específicos /target values**
- **Specific programmes (cost, time reduction)**



PRODUÇÃO/Production

•Proceder ao fabrico/Manufacture of:

- das peças simples/single parts;
- montagem dos subconjuntos/assy of subassy;
- conjunto final quer se trate do protótipo ou pré-série/assy of final assys;

•Proceder ao fabrico de/manufacture of:

- de ferramentas de produção para peças simples/tooling to manufacture single parts;
- de estaleiros de montagem/jigs to allow assy.

LOGÍSTICA/Logistics

- Assegurar o fornecimento de matérias-primas, produtos, consumíveis, etc, necessários às operações (débitos);
Supply of raw material, products, consumables and services;
- Assegurar o fornecimento de ferramentas standard necessária à produção;
Supply of standard tooling;
- Gerir armazéns e stocks (artigos planeados, stocks de rotura, stocks de segurança, pontos de encomenda, mini-max)

Warehouse and stock management (planned items, stock rupture, safety stock, order point, mini-max);

- Política de abastecimento/Supply policies
- Assegurar o fornecimento de componentes e/ou subconjuntos oriundos de subcontratação;
Ensure supply of items from subcontracting.
- Assegurar a expedição dos bens produzidos.
Ensure expedition of manufactured items



GESTÃO DE CONFIGURAÇÃO PRODUTO E FABRICO

Product and manufacturing configuration management

GESTÃO DE CONFIGURAÇÃO PRODUTO (GCP)/Product Configuration Management (PCM)

A GCP é assegurada no essencial através dos seguintes registos (pelo menos):

PCM is ensured through the accomplishment of the following processes (at least):

- identificação onde será aplicado o item a produzir, i.e., é o chamado conjunto superior, e.g., aeronave, subsistema;
identification of the application of the item in the system tree;
- a identificação do componente a produzir;
Identification of the item to be produced;

GESTÃO DE CONFIGURAÇÃO FABRICO (GCF)/Manufacturing Configuration Management (MCM)

A GCF é implementada garantindo que o documento de fabrico incorpora pelo menos o seguinte:

MCM is implemented ensuring that registration is made in the working documents with at least the following:

- a quantidade a produzir;
Qty to be produced;
- a lista de matéria-prima e demais produtos associados (consumíveis, etc);
Raw material and products list;
- a descrição das ferramentas e equipamentos imprescindíveis à produção;
Identification of tooling and equipment to be used;
- a sequência do processo de fabrico incluindo instruções detalhadas (desenhos, normas, etc);
Sequence of the manufacturing process with detailed instructions (drawings, standards, etc);



ACTIVIDADES PÓS-INDUSTRIALIZAÇÃO

Post-industrialisation activities

NA ÓPTICA DO SISTEMA/Systems Perspective:

- **Ajustar a configuração de produto face a modificações**
Adjust PCM after modifications have been issued
- **Ajustar a configuração do fabrico como resultado de GCP**
Adjust MCM as the result of PCM

NA ÓPTICA DA GESTÃO/Management perspective:

Desenvolver programas/to develop programmes:

- **de melhoria de tempos/improvement of production turn around time;**
- **redução de custos/ cost reduction:**
 - **materiais preços/gestão de stocks /subcontratação/etc**
materials prices /stocks management /subcontracting/etc



SISTEMAS *ERP*

ERP SYSTEMS

GENERALIDADES PARA FABRICAÇÃO AERONÁUTICA

General Characteristics for Aeronautical Manufacturing



SISTEMAS **ERP** DE APOIO À FABRICAÇÃO AERONÁUTICA

ERP SYSTEMS TO SUPPORT AIRCRAFT MANUFACTURING

Um sistema ERP (Enterprise Resource Planning) é um sistema cujo propósito é o de permitir administrar, planear e executar de forma integrada as actividades de uma unidade (industrial ou não), isto é, realizando não só a gestão das operações de produção mas também disponibilizando funcionalidades e interfaces com as demais aspectos da administração e da actividade corrente de uma empresa, designadamente:

- finanças;
- recursos humanos;
- comercial;
- logística,
- etc, etc

ERP is a System for the Entire Company - A Global Tightly Integrated Closed-Loop System

Font/source: www.mit.edu

- finance;
- human resources;
- comercial;
- logistics;
- etc

O resultado é uma plataforma informacional complexa (dispendiosa) que permite gerir de forma integrada o conjunto de todas as tarefas directamente relacionadas com a fabricação (ler actividade operacional – “*core business*”), retendo as interligações com as demais funcionalidades do sistema (empresa) onde aquelas se desenrolam.

No mercado comercial existem várias soluções ERP, que no essencial assentam numa base de dados relacional.

The ERP system whose objective is to allow to administrate, plan and perform in an integrated way the activities of a company (industrial or not), that is, enabling to perform not only the management of operations but also it includes functionalities and interfaces with the various management aspects of a company, namely:

The result is a complex informational platform (expensive) that allows to manage in an integrated way the set of activities related to manufacturing (read: operational activities – core business), keeping the links with the various company functionalities where it takes place.

In the commercial market various ERP solutions exist, using in general a relational database.



Ou de outra forma, dirigida para a agora actividade de fabricação, ERP é um sistema que permite realizar o planeamento de todos os recursos (humanos, materiais e financeiros) de uma unidade de fabricação, o que inclui (pelo menos):

- Planeamento do negócio (1er Plano Director);**
- Planeamento das Vendas e das Operações**
- Planeamento da Produção;**
- Gestão de necessidades de materiais (MRP);**
- Gestão de capacidades (recursos tecnológicos e humanos) produtivas**
- Integração com a actividade financeira.**

From a different perspective now applicable to manufacturing, ERP is a system that allows to carry on planning of all resources (human, material and financial) of a production unit, which encompasses at least the following elements:

Business Planning
Sales & Operations Planning
Production Planning
MPS/MRP/CRP
Execution Support for Resources and Material
All integrated with Finance



Este tipo de soluções é modular, isto é, pode ser construído a partir de um conjunto mínimo de funcionalidades relativas a determinadas actividades (normalmente o ponto de começo é a área financeira), as quais podem ir crescendo em função da estratégia e de outros aspectos específicos de uma empresa/entidade produtiva.

O mérito deste tipo de soluções informacionais, permite, entre outros aspectos:

- O recurso a solução informática global e integrada o que favorece a normalização de procedimentos na actividade;
- a utilização de algoritmos matemáticos que permitem:
 - gerir stocks;
 - estabelecer necessidades previsionais em termos de recursos materiais, humanos e de capital;
 - gerir cargas de trabalho de equipamentos (CRP);
 - Definir modos de custeio das actividades.
- controlar (em tempo-real) as actividades em curso, custos e materiais incorridos,
- passar a uma metodologia tradicional a uma de tipo “adaptativa”

A seguir, descrevem-se as características da metodologia tradicional de fabricação vs “adaptativa”.

The ERP solution is its essence modular, meaning that it can be established starting from a minimum set of functionalities related to specific areas (normally finance), which can grow according to the strategy or other specific aspects of the company/productive entity.

The merit of these type of informational systems, includes, among others:

- normalization of procedures across the various activities in a company;
- The use of mathematical algorithms in the following domains:
 - stock management;
 - previsional needs in terms of resources (material, human and capital);
 - capacity (CRP);
 - Costing;
- Control (in real-time) of all work in progress, including incurred costs, manpower, material, services, etc.
- To move from a traditional manufacturing to an “adaptative” methodology.

The next tables describe the traditional manufacturing characteristics vs the “adaptative”.



MANUFATURA TRADICIONAL VS ADAPTATIVA – COMPARAÇÃO E EVOLUÇÃO

Traditional manufacturing vs adaptative – comparison and evolution

Characteristic	Traditional Manufacturing	Adaptive Manufacturing
Philosophy	Push & Stocked	Flexible & Responsive
Order Execution	Batch Executions	Dynamic Reallocations
Capacity Management	Batch & Centralized	Dynamic & Distributed
Exception Management	Centralized & Manual	Automated & Distributed
Planning	Periodic Scheduling	Real-Time Scheduling
Shop-Floor Visibility	Blurred & Batch	Transparent & Real Time
Material Release Schedules	Push	Pull
Analytics	Historical	Real Time
Connectivity	Disconnected/Multiple Databases	Connected MFG-ERP-SCM-PLM
Collaboration	Sequential and Slow	Networked and Real Time
Standards	Proprietary	Open
Driver	Material & Capacity Utilization	Profitability Optimization

Period	1970s	1980s	1990s	2000 & Beyond
Manufacturing Practice	Push Manufacturing	Lean Manufacturing	Flexible Manufacturing	Adaptive Manufacturing
Key Market Differentiator	Cost	Quality	Availability	Lead Time
Performance Indicators	Production Throughput	Cost Management	Segment Market Share	Customer Satisfaction



SÍNTESE COMPARATIVA ENTRE MANUFATURA TRADICIONAL VS ADAPTATIVA
COMPARISON SYNTHESIS BETWEEN TRADITIONAL AND ADAPTATIVE MANUFACTURING

Manufacturing Practice	Characteristics	Philosophy
Push Manufacturing	Mass production	Maximize capacity utilization to lower costs
	Focused assembly lines	Focus on availability and economies of scale
Manufacturing Practice	Characteristics	Philosophy
Pull (Lean) Manufacturing	Produce only what is to be sold	Significant focus on product and process quality
	Flow philosophy	Production smoothing by lot size management
	Limited product variety	Enterprise metrics – across major functions
Manufacturing Practice	Characteristics	Philosophy
Flexible Manufacturing	Significant product variety	Ensure product availability at any cost
	Redundancy availability	Accept variability – focus on economies of scope
	Focus on TOC principles	Enterprise metrics – across major functions
Manufacturing Practice	Characteristics	Philosophy
Adaptive Manufacturing	System integration for visibility	Compete on service and minimize lead times
	Enhance network collaboration	Cost and velocity of flexibility
	Manage by analytics	Collaborative metrics across business partners



CARACTERÍSTICAS ESPECÍFICAS DA MANUFATURA ADAPTATIVA
SPECIFIC CHARACTERISTICS OF THE ADAPTATIVE MANUFACTURING

Area	Feature
Plan	Determine optimal manufacturing sequence, taking into consideration operating margins, material, labor, machine resource availability, shop-floor constraints, and delivery dates.
Execute	Manage production, track resource usage, track production batches, confirm production stages / status, obtain electronic approvals, document results, and log shop-floor activities.
Sense	Monitor and provide visibility about events that impact manufacturing, including inventory, cycle time, order & WIP status, and supplier deliveries. Identify exceptions to relevant personnel.
Respond	Act rapidly to allow relevant manager to modify decision to minimize impact of exceptions, including process delays, rejects, missing goods, breakdowns, change in order size, and supplier delays.
Learn	Enable decision making by suggesting relevant actions based on predefined business rules and continually provide measurement of key manufacturing metrics



Este quadro representa uma compilação das funcionalidades ERP que os sistemas (actuais) comercializados disponibilizam

This table describes the current functionalities that (the existent) ERP system make available.

Tab 1

FUNCIONALIDADE "EMPRESARIAL" ENTREPRISE FUNCTIONALITY		FUNCIONALIDADE ERP ERP FUNCTIONALITY
Gestão Comercial	Commercial Management	Blanket Sales Orders and Releases
Economia e Finanças	Economy and Finance	Accounts Payable Accounts Receivable Administration Bank Reconciliation Budgeting / Cash Flow Business Analysis Business Analytics Currency Management General Ledger
Economia, Finanças e Administração	Economy, Finance and Management	Cost account and Tracking
Engenharia	Engineering	EDI
Engenharia, Direcção Comercial e Planeamento	Engineering, Commercial Management and Planning	Quotations & Estimating
Engenharia e Gestão	Engineering and Management	Routings
Engenharia e Gestão das operações	Engineering and Operations Management	Bill of Materials BOM Link for 3D software Data Collection
Engenharia e Qualidade	Engineering and Quality	Product Configuration Product Lifecycle Management Production Monitoring
Engenharia, Qualidade e Gestão Operações	Engineering, Quality and Operations Management	Document Management Engineering and Workflow
Engenharia, Qualidade, Gestão Operações e Logística	Engineering, Quality, Operations Management and Logistics	Factory Documentation Forms
Engenharia, Economia e Finanças	Engineering, Economy and Finance	Standard Costing
Finanças	Finance	Financial Management Fixed Assets



Tab 1 – cont.

Geral	General	eMail
Gestão	Management	Analytics and Reporting Management Reporting Multi-Site Management
Gestão Comercial	Comercial Management	Supplier Relationship Management Contact Management Blanket Sales Orders and Releases CRM
Gestão Comercial - Clientes e Planeamento	Comercial Management and Planning	Customer Order Management
Gestão Comercial e Engenharia	Comercial and Engineering Management	Field Service
Gestão Comercial e Finanças	Comercial Management and Finance	Purchase Order & Receiving
Gestão Comercial e Planeamento	Comercial Management and Planning	Order Management Progress Billing
Gestão Comercial, Economia e Finanças	Comercial Management, Economy and Finance	Sales Orders & Invoicing
Gestão e Monitorização	Management and Monitoring	Metrics Reporting and Data Capture
Gestão Operações	Operations Management	Bar Coding Document Flow Manager Job Management Labor Performance Manufacturing Order Management Production Management Production Order Processing Productivity Tools
Gestão Operações e Engenharia e Qualidade	Operations Management and Engineering and Quality	Repetitive Manufacturing
Gestão Operações e Planeamento	Operations Management and Planning	Master Scheduling

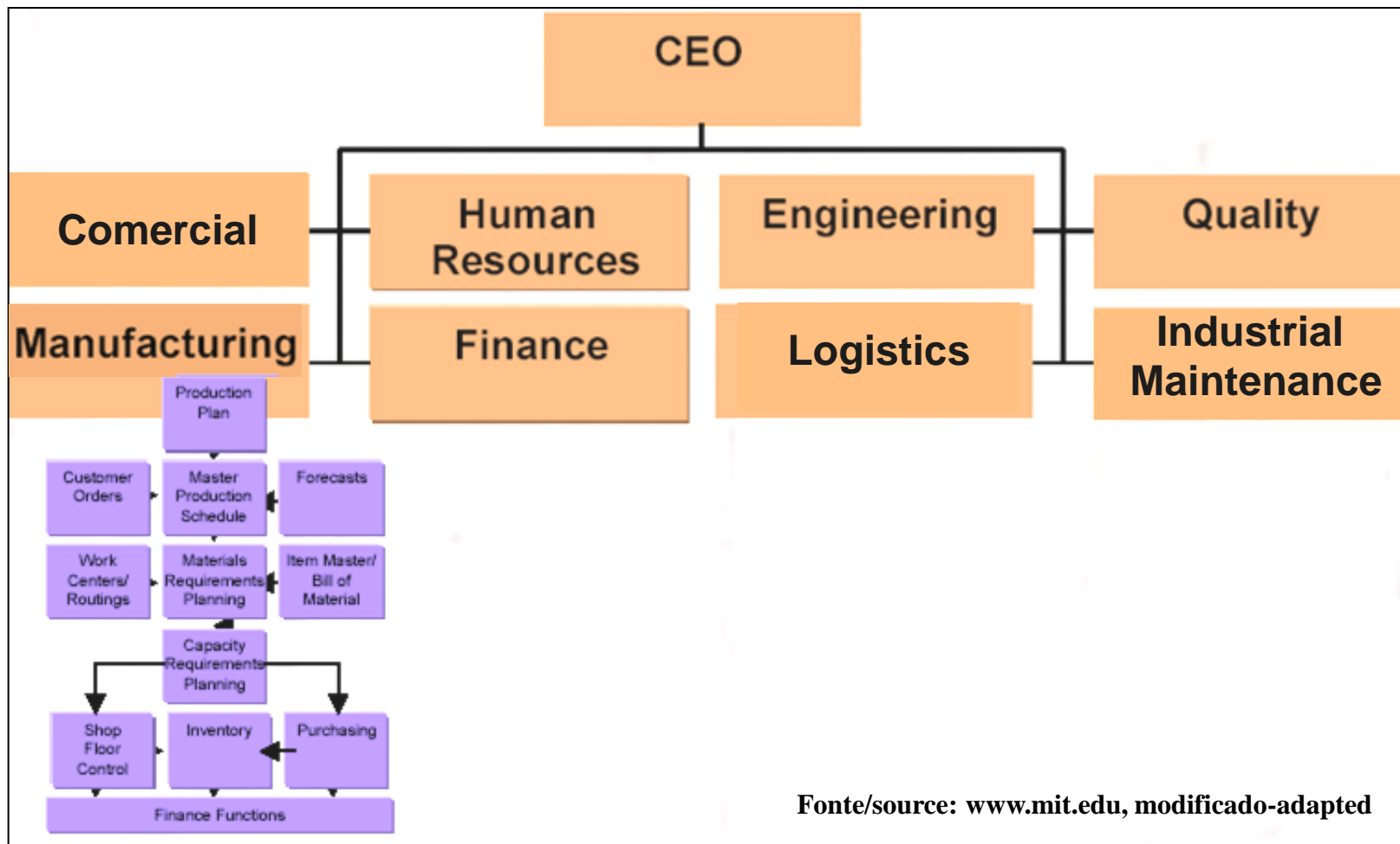


Tab 1 – cont.

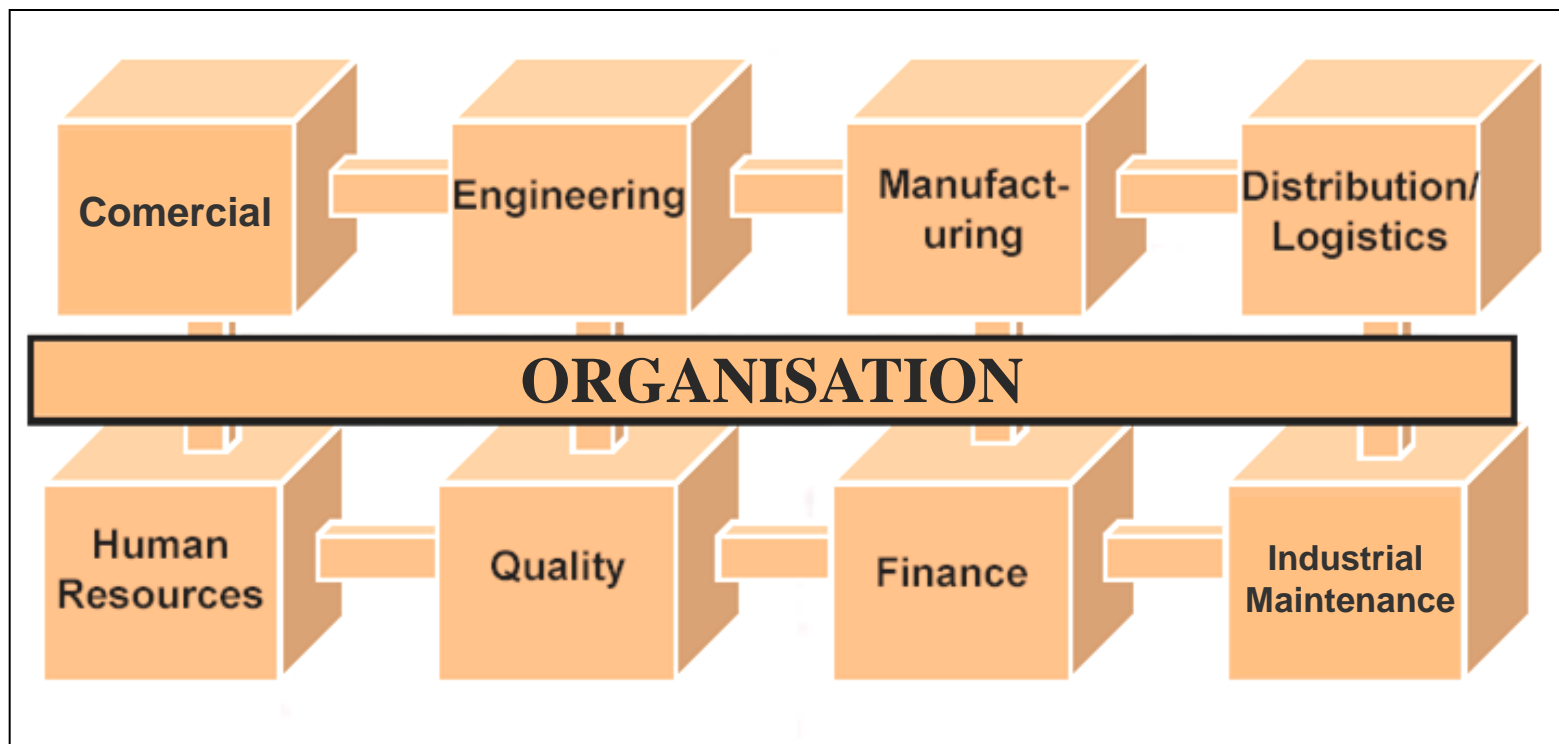
Gestão Operações, Gestão Comercial e Logística	Operations Management, Management Comercial and Logistics	Work In Progress
Gestão Operações, Gestão Comercial, Qualidade e Logística	Operations Management, Management Comercial, Quality and Logistics	Shop Floor Control Shop Floor Data Collection Shop Floor Tracking
Gestão projectos	Projects Management	Project Management
Gestão projectos e comercial	Projects and Comercial Management	Projects & Contracts
Gestão Recursos Humanos	Management Human Resources	Human Resource Management
Logística	Logistics	Distribution Multi-Dimension Inventory Purchasing RFQ Shipping Management
Logística e Finanças	Logistics and Finance	Inventory Management Physical Inventory Purchasing Management
Logística e Gestão Comercial	Logistics and Comercial Management	E-Commerce
Logística, Planeamento e Operações	Logistics, Planning and Operations	Material Requirements Planning
Logística e Qualidade	Logistics and Quality	Lot Trace and Serialization Quality/Warranty Management
Logística, Finanças	Logistics, Finance	Warehouse Management
Logística, Gestão Operações	Logistics, Operations Management	Supply Chain Management
Planeamento	Planning	Demand Forecasting Planning & Scheduling
Planeamento e Engenharia	Planning and Engineering	Order Costing Product Costing
Planeamento e Monitorização	Planning and Monitoring	Event Manager
Planeamento, Gestão Comercial, Economia e Finanças	Planning, Management Comercial, Economy and Finance	Sales Forecasting

Do ponto de vista da integração de um sistema ERP, a próxima figura descreve o respectivo posicionamento relativo do sistema informacional ERP relativa às operações de uma estrutura de fabricação generalista.

The next flowchart describes the integration of an ERP system in a general type of production organisation, covering management of operations.



A figura abaixo apresenta os módulos mais comuns que integram uma estrutura ERP para produção/fabricação.
The figure below shows the typical ERP modules that integrate an ERP structure for production.



Fonte/source: www.mit.edu (modificado, adapted)

As próximas figuras descrevem as funcionalidades típicas que um sistema ERP inclui.
The next pictures describe the typical ERP functionalities.



GESTÃO DO PRODUTO ENGINEERING PRODUCT DATA MANAGEMENT

- Document Creation, Management & Control
- CAD Interface/ Image Management
- Configuration Management
 - Change Order Creation & Control
 - Revision Control
- Engineering Data Management
- Product Information Management
- Technical Data Management
- Technical Information Management
- Engineering Item Data & BOMs

GESTÃO DAS OPERAÇÕES OPERATIONS MANAGEMENT

- MRPII Functionality
 - MPS, BOM, Routings, MRP, CRP
- Sales & Operations Planning
- Integrated Production Configuration
- Statistical Inventory Control
- Flexible Product & Job Costing Options
- Kanban/JIT/Flow Manufacturing Support
- Theory of Constraints/Advanced Planning



ACTIVIDADE COMERCIAL COMMERCIAL ACTIVITY

- Balance Market Demand With Resource Capability
- Develops a Contract Between Manufacturing and Marketing
- A Single Set of Numbers Upon Which to Base Plans and Schedules
- Manages Inventory and Backlog
- Forecasting

PLANEAMENTO PLANNING

- Supply Chain Optimization
- Constraint-based multi-location master planning
 - Generation of feasible production plans across multiple plants
- Constraint-based factory level scheduling
 - Generation of feasible schedules (integrated with feasible production plan)
- Optimized distribution and transportation planning
 - Intelligent allocation of inventory through a network



**LOGÍSTICA
LOGISTICS**

- Purchasing
- Supplier Reliability Analysis
- Distribution Requirements Planning
- Global Transportation Management
- Fleet Management
- Shipping & Receiving
- Import/Export
- Warehouse Management

**GESTÃO RECURSOS HUMANOS
HUMAN MANAGEMENT**

- Requisition Management
- Applicant Tracking
- Employee Master
- Job Descriptions
- Employee Evaluations
- Training & Certification Management
- Payroll Deduction Accounting
- Benefits Tracking



**QUALIDADE
QUALITY**

- Quality Management Plans
- Quality Specifications/Requirements
- Test/Inspection Results
- Cause and Corrective Action Tracking
- Process/Product Certification
- Statistical Quality Control
- Cost of Quality Reporting
- Equipment & Tool Calibration Mgt

**FINANÇAS
FINANCE**

- Financial Budgets
- General Ledger
- Accounts Payable
- Accounts Receivable
- Payroll
- Fixed Assets
- Cash Management
- Activity Based Costing
- Financial Statements

**MANUTENÇÃO INDUSTRIAL
INDUSTRIAL MAINTENANCE**

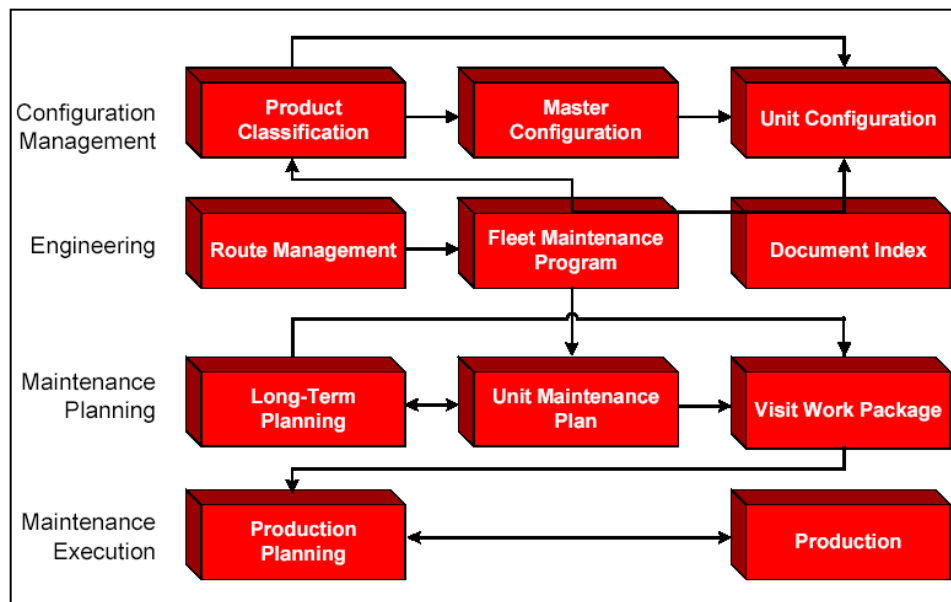
Installation Management

As-Maintained BOM

Preventative Maintenance Scheduling & Control

Service Order Planning & Control

As próximas figuras exemplificam funcionalidades de sistemas ERP relativas à manutenção de companhia de linha aérea.
The next pictures exemplify ERP functionalities related to maintenance of comercial airline,



Fonte/source: www.oracle.com

