DEVELOPMENT OF A NEW GENERATION AIRCRAFT FOR PILOT TRAINING

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Abstract

New demands on pilot training according to the JAR-FCL regulations require new conception of aircraft for pilot training, especially from the early training till the level of business pilot. Decisive in this respect is the achievement of regulation principles required, as well as low operation costs that provides for the training of largest numbers of applicants.
This article describes the conception of a unified series of aircraft, the possibilities in automation of developing tasks, the exploitation of modeling for load and stress analysis, and the aero-elasticity. The results of the cost calculation for the purpose of development and production, and the requirements on capacity and software necessary to ensure real time certification are presented.
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Introduction

In the beginning of 1990’s new and up-to-date conception of an aircraft came to light and aeroplanes have been designed that comply with the more severe requirements on pilot training as specified in the JAR FCL regulation whilst featuring lower operation costs and higher performances. Efforts for a refurbishment and replacement of the GA aircraft can be encountered worldwide. During the 1980’s, a period which was identified by deep drops in sales volumes in the “General Aviation” category of aircraft, a significant increase in the production of planes for administration, travelling and training purposes could be experienced with important plane manufacturers, featuring higher operation economy and more advantageous and economical aspects of the production. People say that significant reduction in the sales volumes occurred only after the pronouncement of absurd verdicts being the product of the implementation of the product liability law. The costs on airplanes have risen disproportionately due to the compulsory insurance costs. Another, equally significant reason of that time, consisted in the extremely broad range of high-quality used airplanes available which the new planes were not able to compete with due to their driven up price. The situation of today, however, is changing very rapidly because of the following reasons:

- The mode of implementation of the product liability law which currently is not being put into effect with such severity against the manufacturers,
- The reduction in the supply of used airplanes on the market, caused partially due to the achievement of full number of years in operation, and also due to the low offer and low sales figures in new airplanes
- Increasing requirements on the engineering level and the equipment of airplanes for pilot training to the JAR FCL regulation.

Also the increasing portion of recreation, training and duty flying is worth of noticing which in this category nearly did not exist until now, and which necessarily will affect its further development. The primarily determination to training, business and travelling flights is assumed to be extended with another special activities such as photographing, monitoring, air traffic control and checking, border and river patrolling, environmental monitoring etc. For this purpose it will be necessary to select an optimum when choosing the purpose and the assumed use of the aeroplane, and to consistently implement the module-type design of the respective development range of aeroplanes by unifying their parts, units and, particularly, the tools. Simultaneously the computerised system means generally known as Computer Aided Engineering (CAE) will have to be used to the highest possible extent.

The project of GA aeroplanes described in this article shows the possibilities of introducing a new, lightweight, multipurpose plane on the market for training, sporting, tourist and business purposes, the parameters of which should surpass those currently encountered.
Three point of view of the aeroplane VUT 100
Conception of the new generation VUT 100 family

The original aeroplane of this series is the VUT 100 plane, intended for basic and continuation training of civilian and army pilots, the training of night and blind flying, general commercial use, tourist and sporting flying, aero-towing and various other special purposes which, as can be seen from the list, cover a significant part of the “General Aviation” category.

Another extension of the above range, with the aim to achieve most ample variety of the plane usage, may principally be attained in two ways: either to design a multi-purpose airplane, probably at lower development and production preparation costs, but affected with all the negative consequences of such a multi-purpose solution, or to design a module-type series of aircraft being compatible to their main field of application and being able, to certain extent, to fulfil also another tasks. These may overlap partially with the particular models pertaining to the series or to change its priority and therefore the level of fulfilment of the requirements specified. On the other hand, the development and production preparation costs do not rise beyond proportion as can be seen with a separate development of a single-purpose type of aircraft.

Experience shows that negative effects of a combination of multi-purposefulness and economical effectiveness linked with the specific needs and engineering aspects of the individual variants are best eliminated by using the module-type series of modifications, versions and various types of airplanes, conformably to their purposes. Such a module-type series provides for reduction and minimization of costs during the development and production stage of various nodes and parts of the plane while using the same construction parts such as the hull, wings, the tail surfaces, the engine installations or also the undercarriage or the cockpit etc., to two different types of an airplane. Cost savings can thus be achieved in the production of tools, and also in the post-production servicing by unifying the airplane construction parts.
Design structure and heredity of the family models

- Common parts that can be used in all family models
- Parts belonging to single-engine models
- Common parts that can be used in all family models
- Parts belonging to double-engine models
Flowchart of an airplane development concept

The following scheme describes developing conception and certification problems of the new aircraft and the significance of MSC.Software in this process.

FLOWCHART OF AN AIRPLANE DEVELOPMENT CONCEPT

- Regulations
  Requirements
- Static Strength
- Dynamic strength - aeroelasticity
- Requirements on Stiffness
- Preliminary testing of samples
  Methods for calculation of stress, tension, deformation load of plane
  MSC.Nastran
  MSC.FlightLoads
- Assembly of load-bearing structure of the plane
  Conditions necessary to ensure the requirements on structures
  MSC.FlightLoads
  MSC.Construct
  MSC.Patran
- Design and production processing design of the structure including complementary requirements
- Impact of fatigue strength on the load-bearing structure
  Determination of necessary tension level in order to fulfil the fatigue strength requirements
  MSC.Fatigue
- Program of structure inspections
- Consequences of failures of function systems
- Regulation reliability requirements
- Reliability parameters in effect for function systems
- Design oriented inspections of the state – diagnostics
  MSC.NVH Manager
VUT 100 airplane model drawn using the CAD Unigraphics system as the basic geometrical model of aeroplane for MSC.Patran modeling.

Study of a two-engine VUT 200 version of the family
Conclusion

The project of the new generation of VUT 100 family aeroplanes described in this paper is based on the efforts of introducing a new, light, multi-purpose aircraft to the market, to be used for training, sporting, tourist and business flights at the beginning of the 3rd millennium. This aeroplane’s parameters shall surpass the currently achieved world level in aerodynamic purity, low purchase and operation costs, the safety and reliability level. The project originated at the Institute of Aerospace Engineering of the Faculty of Mechanical Engineering of the Brno University of Technology, with the support of the Ministry of Industry of the Czech Republic and in co-operation with other aircraft industry plants and organisations. During the design the following SW means were primarily used: MSC.Patran, MSC.Nastran, MSC.Construct, MSC.Fatigue, MSC.FlightLoads, MSC.Dytran and others. New complex programming tools have been developed, mainly for the calculation of aircraft loads, and research works in the area of production technology have been conducted along with the application of composite materials.

References

(1) FAR Part 23, JAR Part 23 regulations

(2) MSC.Software products documentation