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DESIGNING PROCESS OF LANDING GEAR IN 3D CAD PROGRAM

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Abstract

This article presents selected issues related to the design methodology of the landing gear during the construction process. The 3D modelling of the landing gear nowadays is very popular method, which simplifies the process and reduces the costs of the prototype. The author used the designing program Solid Edge ST 7. The concepts and phases of designing will be shown in this elaboration. Readers can see the problems resolved by designers and this is showing the scale of designing challenges.

The landing gear consist of many parts and every of this parts needs to be design to meet the requirements of construction. Only experienced designers can effort to design landing gear because they have to acquire specific knowledge. The aim of the paper is to discuss design process from the very beginning first steps to the final version of the landing gear. All of different factors like weight, durability, resistance of the weather are taken into account when designing a prototype of the landing gear as well as economical factor of the design. It is also necessary to verify the design during its creation using experimental and laboratory test data from other similar designs. The article also subscribes some methods, which help designer to find the proper solution. The presented landing gear was designed by Landing Gear Laboratory team Institute of Aviation.

Keywords: *transport, airplanes, designing, main landing gear, CAD*

1. Designing phases of landing gear

The purpose of this article is to describe the process of designing landing gear in 3D CAD model program. Nowadays the 3D designing is very popular because this method decreases the cost of preparing the prototype. The changes of the model are very easy so the designer can fulfil the client requirements without problems. The client requirements like low costs of production parts, quality, technology and others.

The designer used Solid Edge ST7 the 3D CAD program in this designing. This program consists of two different modules: traditional and synchronous. The traditional module is very useful because it contains the whole history of operations. It is possible to create the dimension of every operation and very easy change it. The synchronous module does not include full history of operations. This module allows user to change design faster than traditional. Choice of the design method depends on the designer skill lever and personal preferences.

The model should be as real as it is possible and easy to change and produce. The designer should use cheap technology if possible but need to take into account the quality too. The machine park limits the possibility of designer creativity.

Preliminary phase of the designing is the implementation the idea, scheme of designing of the landing gear. Later the idea is altering and the design becomes more detailed. The parts are subjected to mass and durability optimization. The main target of this optimization is to decrease mass and maintain the proper durability, which depends on the loads.

In addition, the space of the retraction of the landing gear is very important because it influences the leg shape. Very often, the retraction space is not sufficient. Nevertheless, the designer needs to find the proper solution. It should be possible to retract and extend the landing

gear in proper way. During the designing, designer needs to take into account, approximate shock absorbers strokes and general kinematics concepts of the landing gear [4].

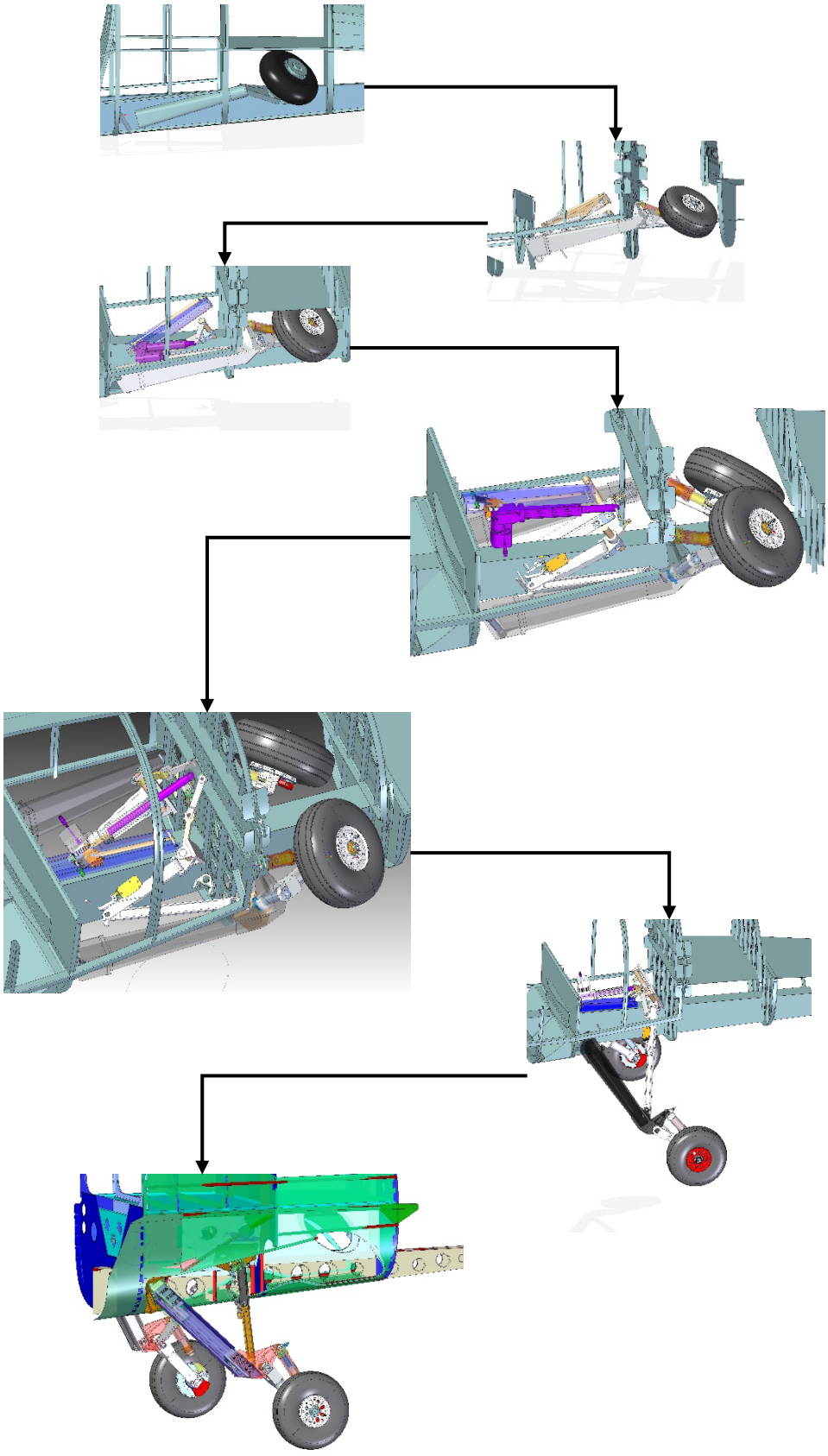

Fig. 1. The construction progress of landing gear

In the example presented in the Fig. 1, at first there was the design concept with separate actuator for single main landing gear. Later this concept was upgraded and one stronger actuator was used for both landing gears. Meanwhile retraction system was changed few times and all parts were upgraded. In addition, the leg was changed (Fig. 1). Of course, in this case the reader should consider only the landing gear changes not including the changes in fuselage.

The three most important groups in the construction process are design, analysis and tests.

All of these groups are connected to different design phases and are very important.

Design analysis/calculations need fixed load state subscribing the value, type and frequency of the load. If the loads are not updated in appropriate time, there could be a risk of faulty design or need of last minute redesigning what is not always possible.

There are many different factors, which need to be considered and taken into account while designing. Some of them are listed in previous author's articles [7].

The other important thing, which the designer has to take into account, is reliability of the design of the landing gear. The reliability is very close connected with passengers' safety, so it is very important to consider it [5, 6].

The last phase of the designing process should end before laboratory tests.

2. Different methods of finding the proper construction solution

During the designing process, there are some methods, which help the designer to find the proper solution, which is very important in order to prepare the design.

From the methodology point of view, designing is a process of optimisation of the design when the goals are defined and the requirements are changing. The solution can be only realized in actual conditions. The designer is frequently looking for the solution of difficult designing problems.

There are also intuitive methods, which are used during the solution finding process.

The design evolves after the phase of finding ideas. Later the problem changes and lastly the problem is resolved.

There are different methods of finding the designing solutions [3]:

- Brainstorm – this method is based on the flow of the ideas, which are exchanged during meetings. The group of people should consist of different professions. The ideas sometimes are stupid but people in-group should not criticize it. People shouldn't be prepossessed to other people ideas,
- Method 635 – this method is variant of the brainstorm. This method was proposed by Rohrbach. After the group of people get the project, they analyse it, later they sketch three different solutions and subscribe it in a few points. Later neighbour give the solution to the other neighbour, who after reading it, develops three new solutions. Six participants continue the procedure as soon as they achieve the set of solutions or one complete solution.

  The flaw of this method is that some persons are less creative if isolated,
- Delphi method – in this method the manager of the project or designer asks specialists (in writing) for the solution of the problem. The answers should be also in written form. This method is very good if the designer has the possibility of asking the specialists,
- Synectics– this method is similar to brainstorm but the manager of the group is looking for the solutions from not technological area. The manager helps to find the solutions and respects the order of procedure: show the problem, analyse the problem, understand the problem by everybody in group, compare with other areas of life, analyse the new solution, compare the different solutions and gradually create the solution of the problem,
- Combined methods – the best idea is to combine all of these methods to achieve the best solution. For example during the brainstorm you can use synectics and, if you need, use Delphi method to ask specialists who are not in your group,

– Discursive method – in this method the designer gradually resolves the design problem (step by step).

All of these methods can be used during the designing phase. Off course there are some other methods and the described ones are only the examples

There are some factors, which are very important:

– experience of the designers,
– specialised computer tools,
– working in group,
– regular meetings,
– appropriate time of duration of the project,
– analysis of different solutions,
– final solution selection,
– improvement of the solution,
– market research of the parts,
– specialised design knowledge,
– motivational system.

All of these factors are very important when creating of the new design.

3. General overview of the landing gear

In airplanes, there are two main types of arrangement of landing gear. In first arrangement, there is nose landing gear (NLG) and main landing gear (MLG). In second arrangement, there is main landing gear and rear landing gear (RLG) [8]. The main role of main landing gear is to absorb the impact energy during the landing phase. Other important function of landing gear in every airplane is presence of the brakes, which have influence on passenger safety. The brakes are typically mounted on main landing gears. The main role of nose landing gear is changing the direction of the airplane during taxiing phase. In this article author focuses on MLG design. In the picture (Fig. 2) below the reader can see the example of MLG design. The model is an assembly, which consists of subassemblies. Every subassembly consists of single parts. Every part should be prepared as detailed as possible.

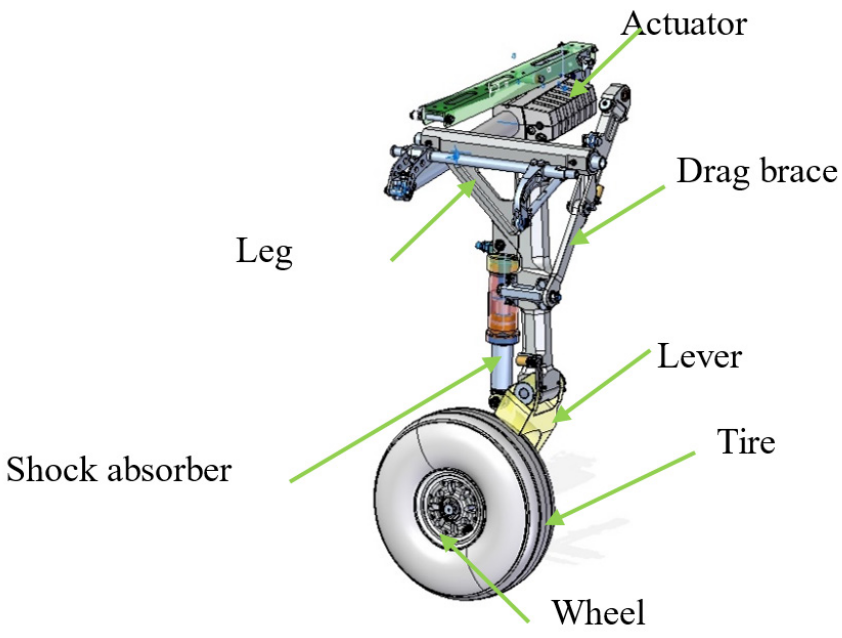

Fig. 2. The landing gear 3D model

Landing gear consists of the following parts:
- Leg,
- Lever,
- Drag brace,
- Shock absorber,
- Actuator,
- Wheel,
- Tire,
- Brake,
- Mechanism of retraction,
- Bolts, nuts, sleeves and washers.

The special landing gear terminology is used to describe the parts. All of these elements are the parts of the landing gear construction and are necessary for the proper work of the landing gear. All parts are connected by nuts and bolts. These parts are made from steel, aluminium, and titan. Example of single steel part is shown below (Fig. 3).

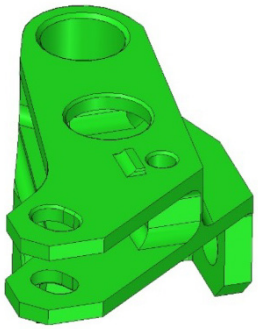

Fig. 3. The 3D model part

All of different factors like weight, durability and weather resistance are taken into account when the designer prepares the construction. Every part needs to be optimized.

There are different material properties of parts which need to be taken into the account during the designing phase: deformability, hardness, impact strength, strength, cracking resistance, damping, wear resistance, creep relaxation, fatigue strength, sensitivity of notch effect, corrosion resistance, thermal and electrical conductivity, machinability and weldability.

During the designing phase of the machine, it is important to choose the correct behave rule of the parts. There are three different rules:
- rule safe – life – all the parts work without damage during the whole cycle of life even though there is high possibility of destroying the parts,
- rule fail – safe – the parts could be cracked but the whole machine could be safe without any dangerous consequences,
- the redundant system – the solution is doubled. If one solution fails, the other performs the function.

Different types of redundant systems are described above (Fig. 4) [3].

4. Summary

After the designing process, the draft of every model is prepared. In next step, the parts are manufactured and the landing gear prototype is assembled. Later the landing gear is tested in landing gear laboratory. If all tests are successful, the landing gear design can be used in airplane. In Landing Gear Department, the knowledge of design process of the landing gear is based on the experience, professional literature and previous documentations (designs). As the reader can see,

the design process lasts long and is always full of changes. The computer tools like 3D CAD programs are very useful and cost-effective because during the designing process the designer has to consider multiple factors in order to choose the best solution of the design.

This article presented selected issues related to the designing process using 3D modelling software with emphasis on the methods, which helps the designers to find the proper solution.

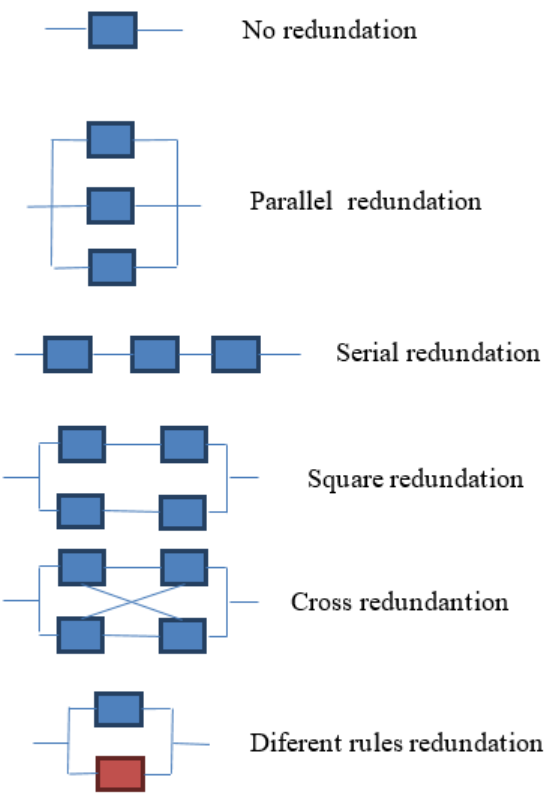

Fig. 4. The redundant systems

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