Numerical Geometry Based Optimization Used to Solve the Challenges of PW-100 Aircraft Design

Wojciech Grendysa

Faculty of Power and Aeronautical Engineering,
Warsaw University of Technology,
Nowowiejska Street 24,
Warsaw, mazowieckie 00-665, Poland
wgrendysa@meil.pw.edu.pl
http://zsis.meil.pw.edu.pl.

ABSTRACT

The following article describes the authorial optimization process based on numerical geometry developed by the author during the works on the MALE class UAV project. The original part of the presented process is not the optimization procedure itself, but a way of formulating this process allowing the use of numerical geometry of the designed subassembly to determine the variable space, boundary conditions and objective functions in such a way that a standard optimization procedure can be applied.

Optimization is very useful process in design process of an airplane. It's often used in aerodynamic design analysis, or in structural analysis based on finite element methods. A different application of optimization is shown below.

The presented process is implemented in the Siemens NX software environment and uses numerical geometry to determine objective functions, boundary conditions and kinematic constrains. The main idea behind the procedure presented below is to combine the possibilities offered by a computer aided design system and in particular a sketch module with optimization.

The author's original idea is to combine the standard optimization method with the tools available in the CAD type program modelling module and to configure these tools in such a way as to obtain a kinematic layout that adapts optimally to the given boundary conditions.

The optimization process presented below is impossible or very difficult to perform in any other way. This is due to the fact that in both presented cases the objective function is implicit function and cannot be written in an explicit form. Moreover, the following processes of searching for the best set of geometrical parameters are not possible to perform directly, using a typical CAD program. This is because these programs work according to a time order scheme and in these tasks the results depend on themselves.

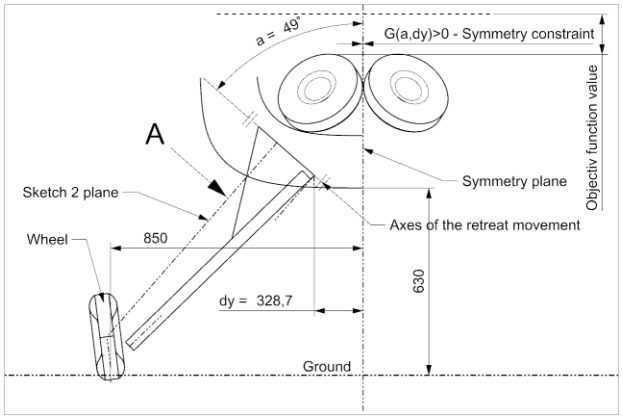
It is worth emphasizing that the whole process is performed in one environment (Siemens NX, modelling module) and that it is an environment in which the designer normally works.

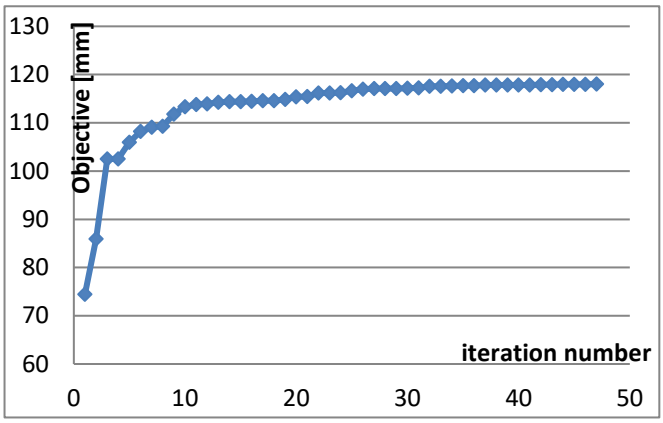
Developed methodology allows for optimization of the mechanism parameters to ensure the best fit to the given geometry. This methodology was developed during the conceptual design of the retractable main landing gear of PW-100 airplane.

Two examples of the use of this scheme, based on numerical models created in Siemens NX 11 and using the optimization module implemented in this program, were presented.

Case 1. Numerical geometry based optimization of retractable undercarriage.

The goal of the optimization is to find such a set of undercarriage geometry parameters that gives us the smallest space in the fuselage necessary to completely retract the landing gear.





The optimization module uses the Powell method for finding a solution. In the optimization module, an objective function, two independent variables and additional constraint are defined. An additional constraint is that the plane of symmetry must not be exceeded.

Case 2. Numerical geometry based optimization of control system.

The second example shows the geometric parameters optimization of the PW-100 airplane control system. The goal of the optimization procedure described below is to find such geometrical parameters of the elevation control system to ensure that the given assumptions are met.