Configuration Global Change at the Conceptual Design Level, A Particular Way for the Evolution and Optimization of the Design

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Aim of this paper is to investigate about opportunities, in aircraft conceptual design, of performing global changes of layout by modifying the previous version or by starting a completely new design.

Even if numerical characteristics of an aircraft concept (i.e. main dimensions, weights and more relevant performances) seem to be adequate, and so to be maintained, changes in architectural layout may be of interest; usually a global change of layout means a new design run because of interactions between architectural (qualitative) characteristics and numerical (quantitative) ones.

By the way, in a context of design activity greatly based on CAD-3D sw tool, the definition of the new configuration by utilizing a previous one could be a good strategy; this thesis will be illustrated in the paper by referring about a "Design Case" driven up by Aerospace Systems Engineering Group of Politecnico di Torino

Some years ago the Aerospace Systems Engineering Group of Politecnico di Torino started a series of studies about advanced trainer aircraft, in order to improve Flight Safety levels by increasing Pilot's skill, in addition to caring intrinsic Safety levels of the aircraft.

The result was a "Delta-Canard" a.c. concept called SCALT [1], [2].
The study was driven up till to sub-systems level with extensive utilisation of CAD-3D in all SCALT design process, as far as possible, to obtain a "digital mock-up", already in the early phases of design (Digital Mock-Up at Conceptual Level - DMUCL).

We can observe that the SCALT "Delta-Canard" layout is related to the clearly said idea [1] that SCALT could be a European solution for training of new Pilots for Eurofighter 2000, Dassault Rafale and Saab Grippen.

In a more global context, and also considering the time passed from the SCALT conception, configurations unlike Delta-Canard could be preferred today; the motivation could be the prevision of a future large diffusion of operational a.c. like the Lockheed F 22 "Raptor" and, in particular, the new JSF Lockheed F 35.

On the basis of these consideration, i.e. the prevision of great prevalence of configurations with horizontal tail surfaces in the future operational fighters, the Aerospace Systems Design Group of Politecnico di Torino, in the ambit of continuous study of new a.c. concepts (to maintain an adequate skill in the field), took the decision of defining a new advanced trainer (CT / LIFT) concept, similar to the SCALT by the points of view of numerical characteristics and subsystems configuration, but with a new global architectural layout similar to the Lockheed X 35 one; the new concept was called SCALT35 and it is now under development.

The basic mission considered is the same of the previous SCALT. It is an Air To Ground mission, in particular[1] a LOW-LOW-LOW penetration with combat time (launch of anti-radars or air to ground missiles) of 3 min; the radius of action is 350 km and payload is 1224 kg; these values drive us to a TOGW of 7500kg, value that, on statistical way, suggests an estimation of empty weight We = 4280 kg.

With the hypothesis of 100kg for a pilot weight and 120kg for operational devices weight it is possible to define:

- Fuel weight: Wf = 1775kg → 2.100 [mc]
- Landing weight: Wl = 5625kg
- Manouvring weight: Wm=We+200 +120+Wf/2= 5487Kg

Please note that the last assumption is related to a training mission;
the Wm value, with the idea of having a very realistic training, suggests a value of T/W ratio about 1, with the adoption of the ITEC TFE 1042-70, advanced version of existing engine; the engine has been already chosen for the original SCALT.
Considerations about wing loading value, in particular influence on Landing distance and on Take off distance (in this case accounting also the T/W value) suggest a wing area value: S = 21.6 mq

Please note that all these steps are completely equivalent to the previous SCALT ones; so we also adopt the same Aspect and Taper ratios values for the wing and the same a.c. length (l = 11.6 m) of the previous SCALT.

On the contrary the layout definition, at this moment still under development, will be quite different. In particular we will have:
-a) Dissimilar wing geometry (sweep back angle) and position relatively to the body
-b) Completely new empennages configuration
-c) Completely new landing gear main elements, because of "a)"
-d) The internal provision of a lifter engine, in order to achieve VTOL capabilities in conjunction with vectorizing main engine thrust. As alternative, in CTOL variant, an internal weapons bay will be obtained.

To synthesize the main feature of new a.c. concept SCALT35, in comparison with the previous SCALT, please refer to fig. 1 and fig. 2.

The new SCALT35 concept, at this stage of development, has been checked, following the Group conceptual design methodology, by the points of view of aerodynamic characteristics and of weight congruency. As expected, these steps gave results closely similar to the previous SCALT ones.

We think that the following activities, in particular more detailed verifications and analysis, will confirm that SCALT 35 performances will be similar to the SCALT ones; on the contrary we think we will have to consider and manage differences in the sphere of costs, operational evaluations, analysis based on DMUCL, like accessibility studies and Safety zonal analysis and Risk Analysis, especially for VTOL version.
way a very important aspect, in our opinion , is the easy way in which a so interesting a. c. concept so different in comparison with previous SCALT has been defined on the basis of the same SCALT, specially the CAD-3D modellisation.

[1] "By the *vehicles", Aircraft Design 3 (2000), Elsevier Science Ltd.*

Please note that the experience linked to the described activity contributes to improve skill of students that at various levels of their training are involved in the project.

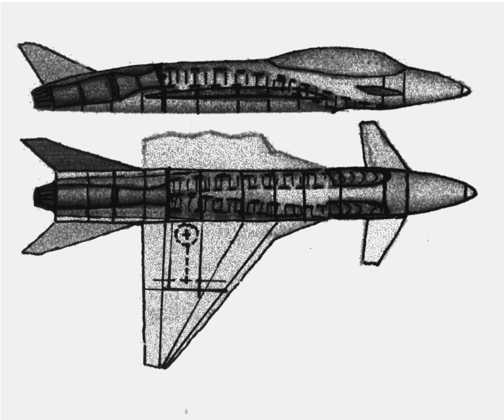

Fig. 1 SCALT layout [1]

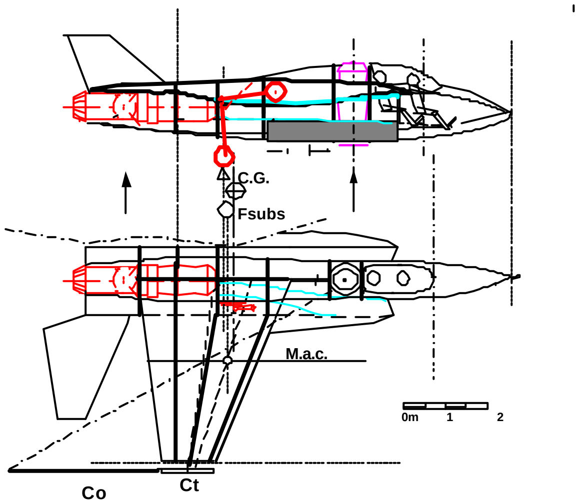

Fig. 2 SCALT35 layout

BIBLIOGRAPHY

[1] S. Chiesa, M. Di Sciuva, D. Camatti, S. Corpino, M. Pasquino – "Utilizzo di CAD-3D parametrico per studi di configurazione e Digital Mock Up", XV Congresso Nazionale AIDAA, Torino, Novembre 1999

[2] S. Chiesa, M. Di Sciuva, D. Camatti, S. Corpino, M. Pasquino – "Utilizzo di CAD-3D parametrico per studi di configurazione e Digital Mock Up", XV Congresso Nazionale AIDAA, Torino, Novembre 1999

[3] D. Camatti, S. Corpino, M. Pasquino – "Digital Mock Up: a useful tool in Aircraft Design", 22nd ICAS Congress, Harrogate, UK, August 2000

[4] J. Roskam – "Airplane Design: preliminary sizing of airplanes" Volume 1, University of Kansas, USA, 1988

[5] S. Chiesa, D. Camatti, S. Corpino, M. Pasquino, G.L. Sembenini – "Safety by zonal analysis at a very early phase of system design", ESREL 2001 "Towards a safer world" – Torino, 16-20 September 2001

[6] D. Camatti, S. Chiesa, S. Corpino, G. Luda di Cortemiglia, M. Pasquino – "Maintainability and accessibility; logistic advantages by application of CAD-3D digital mock-up tecnique. International Logistic's Congress (S.O.L.E.) – New Orleans, August 2000

S. Chiesa, D. Camatti, S. Corpino, M. Pasquino, N. Viola – "Hypothesis about cost-effective unmanned offensive airplane