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The Digital Twin and uncertainty handling in aiming for a Robust Design

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“All models are wrong, but some are useful”. This fundamental quoting from George RP Box puts focus on the awareness on actual uncertainty and approximations that all models have to deal with. In engineering most product designs nowadays are developed and built including significant simulation efforts based on advanced multi-physics models. In aerospace engine design mechanical, thermo-mechanical or aerodynamic simulations are the dominant models that are used in order to set a product design that are meeting the customer’s requirement. Computer modelling in Aerospace design has been done for quite a long time, and the Digital Twin concept is rather young as a concept. On the other hand the resolution in analytical models has largely enhanced during the last decade, and therefore the Computer Aided Models are experienced many times as an exact twin copy of the reality.

When performing a design study parametric Computer Aided Finite Elements and Finite Volume models are applied, and studies can be performed with a wide range of parameters varying to simulate a so called Knowledge Space of the parameter settings. This means that optimization with respect to requirements on a desired customer solution more easily can be carried out to meet the desired so called Design Space. However, by the size of the multi-physics optimization problem, when adding the handling of the manufacturing capability with restrictions on dimensions and tolerances as well as the design margins show a true challenge to find a Robust Optimized Design. Therefore certain type of tricks need to be done to find a product design that fulfills the customer needs as well as giving safety margins when applied on an aircraft.

In this presentation examples are given on how statistics concepts are influencing how design optimization is carried out. Both in the software platform that allows for adaption of the latest response surface fitting algorithms, as well as handling of variation and uncertainty in finding the Robust Design Optimized solution. Identification of obstacles and challenges, while working on finding a desired customer design definition, with a statisticians view point.

Primary author: Dr KNUTS, Sören (GKN Aerospace Sweden)

Presenter: Dr KNUTS, Sören (GKN Aerospace Sweden)

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