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Vibration related issues concerned with Aircraft Wings and Engines accounting for Impact and Flutter in Lifing and Optimization

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During the II World War, we have witnessed significant design developments in aviation history. The piston aircraft with bi-plane wings have given way to beginnings of jet engine propulsion with Frank Ohain and Frank Whittle developments of jet engines. Simultaneously the first digital computer using thermionic valves was developed that ultimately ushered the era of High Performance Computing. The early 20^{th} century design practices using approximate approaches coupled with testing while designing have given way to Simulation Based Engineering Science using High Performance Computing (SBES with HPC). Optimization procedures that evolved in Science Revolution beginning with Brachistochrone problems that have remained analytical suddenly found applications to complex engineering structures and flows through Topology Optimization in 1980's. This brought us to advanced design practices in 21^{st} century. The current state of art of designs and optimizations in aeronautical applications will be discussed in this seminar.

1. Weight reduction has become a necessity to improve fuel efficiency capacity addition in civil and defense aircraft; these design evolutions and modifications will be first discussed
2. Approximate designs gave rise to large stress concentration factors and strains in plastic range leading to globally elastic and locally plastic structures; shape optimization led to minimization of local strains that led to improved fatigue lives, we will discuss the case studies in this regard
3. Optimizations involving multi-physics applications became possible such as those involving fluid-structure-thermal coupling; case studies in conjugate heat transfer, flow induced noise in automobile cavities, aircraft cock-pits will be discussed
4. Weight reduction through usage of composites for fan blades of aircraft engines, aircraft wings will also be discussed through case studies
5. With heavy computational efforts, particularly CFD and structural crash analysis, Metamodel based Design of Experiments approach for optimization is now becoming practical and a few case studies of automobile crash and three dimensional shape optimization will be presented
6. We will finally discuss a case study of futuristic Fusion Reactor application in design optimization of Tritium Breeding Modules involving cryogenic temperatures and intense magnetic fields exposed to plasma temperatures through vacuum.