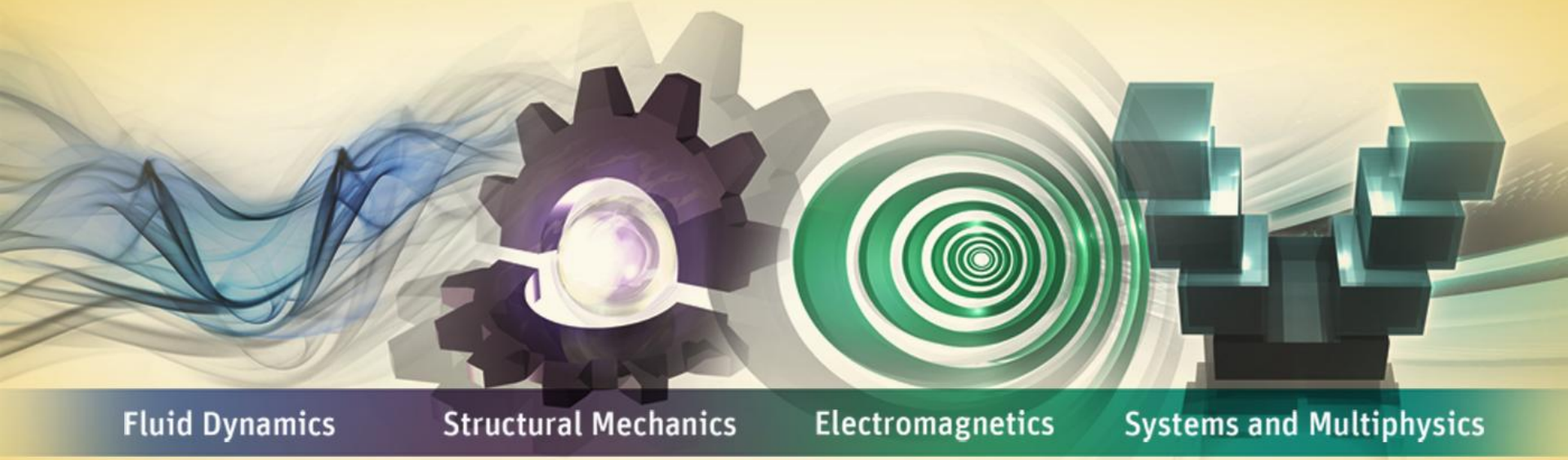
ANSYS

Realize Your Product Promise™

Multiphysics Modeling and Simulation for Armament System Improvement



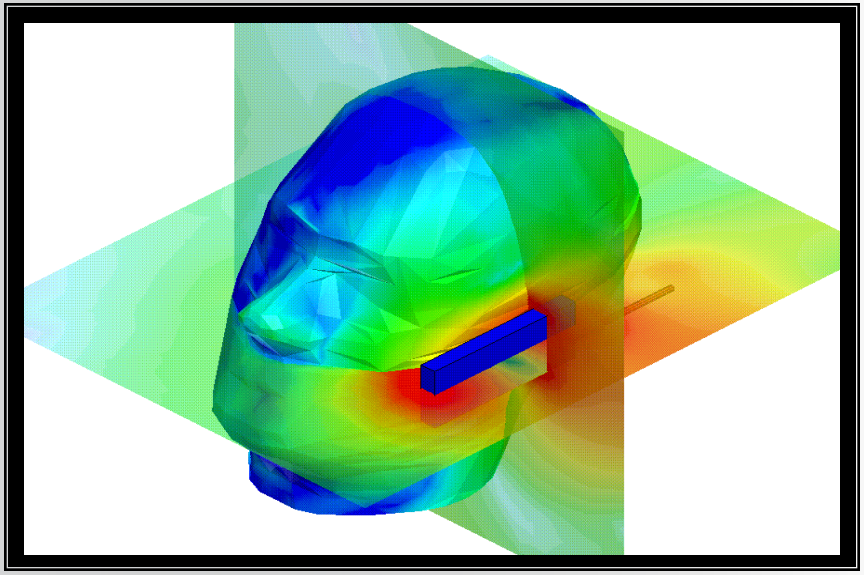
Bill McGinn

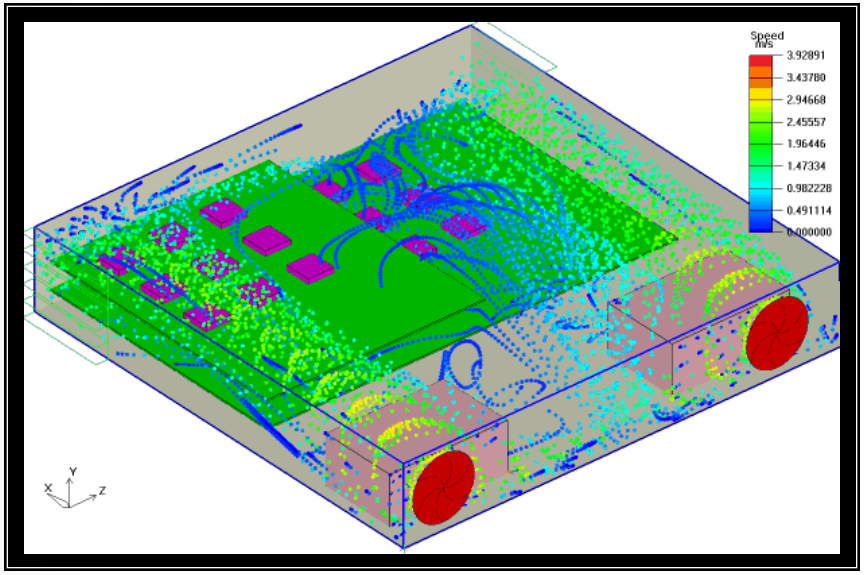
Lead Application Engineer

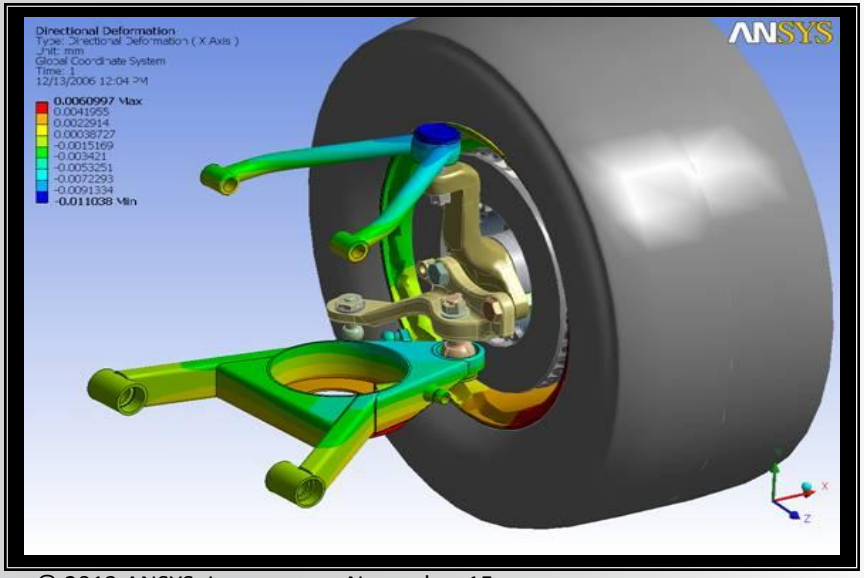
ANSYS, Inc

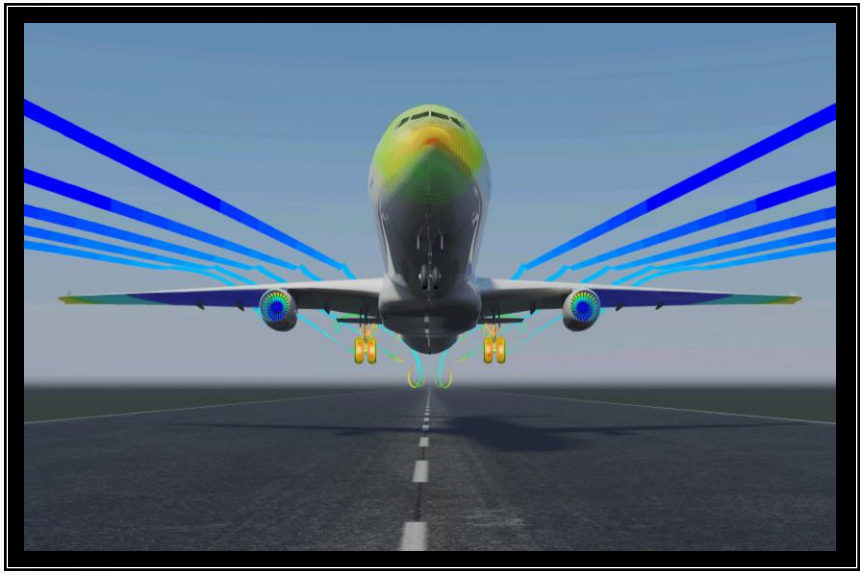
Bill.Mcginn@ansys.com

Physics-Based Simulation
Electromagnetics, Thermal, Structural Mechanics, Fluid Dynamics









- **Industry Trends**

Industry Trends Are Reshaping A&D Product Development

Rising Fuel Costs

Safety and Environmental Considerations

New Space Race

Fiscal Constraints

Geopolitical Drivers

Warfare Revolution

- **Key Implications**

*Constricting Defense Budgets Cause Focus On Affordability, Reduction In New Procurement And The Extension Of The Service Life Of Equipment--- Need to design for **Affordability***

Fiscal Constraint

- **Do more without more**
- **Shift from procurement to sustainment**

Key Business Initiatives

- Design for Affordability
- Engineer for Sustainment

*Commercial And Military Competition Drives Innovation And Increases The Pressure On Deployment Timeframe --- Need to Design and Implement systems **Faster**.*

Geopolitical Drivers

•Emerging competition in commercial aero and space

• System Sophistication

• Heavy investment in defense technologies in emerging markets

Key Business Initiatives

- Faster Design Cycles
- Commercial design practices
- Employ up-front analysis

*As The Nature Of Warfare Changes, The Demand For Intelligence, Surveillance And Reconnaissance (ISR) Technology Is Increasing Significantly --- Need to develop **Smart** systems*

Warfare Revolution

- **Field recognition of the importance of novel ISR capabilities**
- **More sophisticated, robust and affordable unmanned systems**
- **Increase sensor complexity**
- **Manage size, weight and power (SWaP)**

Key Business Initiatives

- Design in more inteligence
- Increased use of electronics
- Increased need for Multiphysics evaluation

Industry trends are driving the development of more sophisticated electronic systems in shorter time frames and with greater fiscal scrutiny

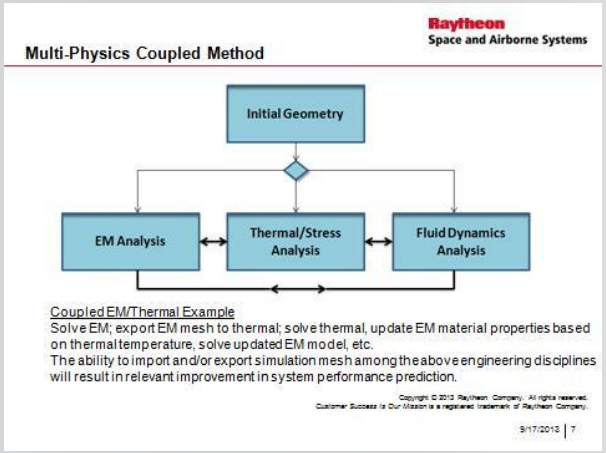
Fiscal constraint, coupled with the increasing demands of sophistication, competition and time pressure mean that system robustness is more important than ever

Working with thousands of customers around the globe, we (Ansys) observe industry leaders adopting best practices to tackle robust design through simulation based engineering

Simulation based engineering is a key enabler for Robust design using Accurate, Multi-Physics based analysis tools.

- Multi-Physics Simulation

Why is multiphysics based design a best practice for robustness and affordability?



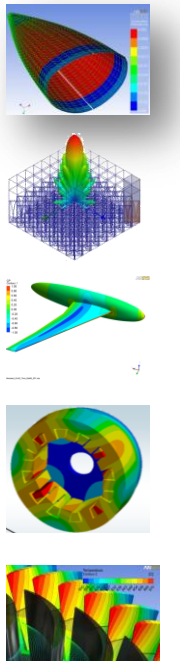
Amedeo Larussi
Sr Principal Electrical Engineer
Raytheon Space and Airborne Systems

"Traditional engineering methods are not able to accurately anticipate performance degradation and /or product failures because does not combine all performance factors"

Idga/webinars

ANSYS's Aerospace and Defense Best Practices Derived from Cross-Industry Knowledge Bring Best-In-Class Insights to Solve Your Product Development Challenges

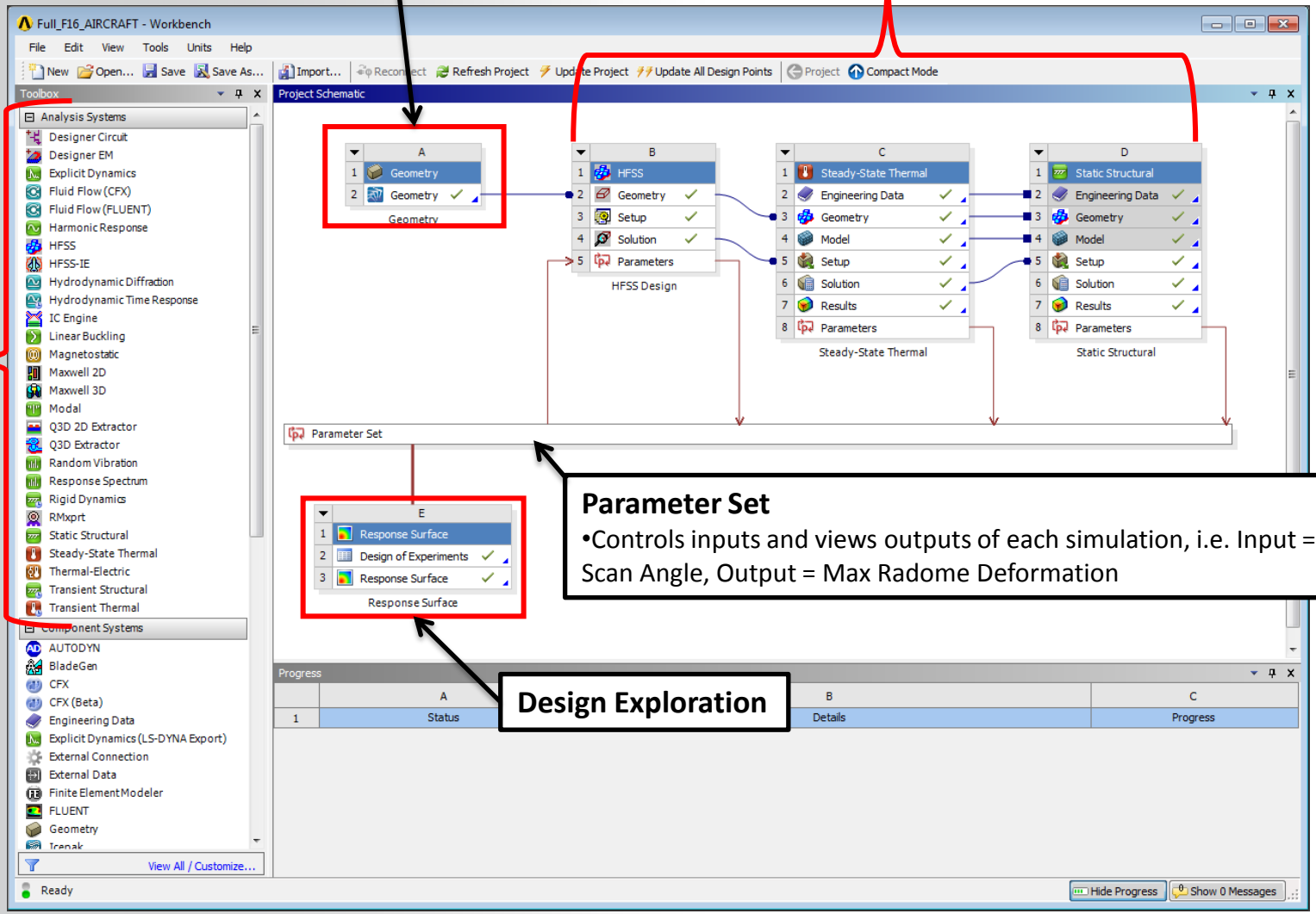
ANSYS's Cross-Industry Best Practices	ANSYS's A&D Best Practices
Advanced Lightweight Materials Design	Efficient Design Of Lightweight Composites For Multifunctional Applications
Robust Electrical and Electronics System Design	Integrated Multiphsyics Simulations for Robust Platform-Payload Integration
Fluid Structure Interaction	Integrated Multiphysics Simulations for Emerging Aeroelastic Challenges
Electric Machine Design	Robust, Efficient Electric Machine Design for the More Electric Aircraft
Fluid-Thermal System Design	Reduce Fuel Burn Through the Design Of More Efficient Engines



The Workbench Environment

CAD Geometry

Coupled Physics Solutions
- Automated geometry transfer and data exchange of solution shown by connections



Available Physics

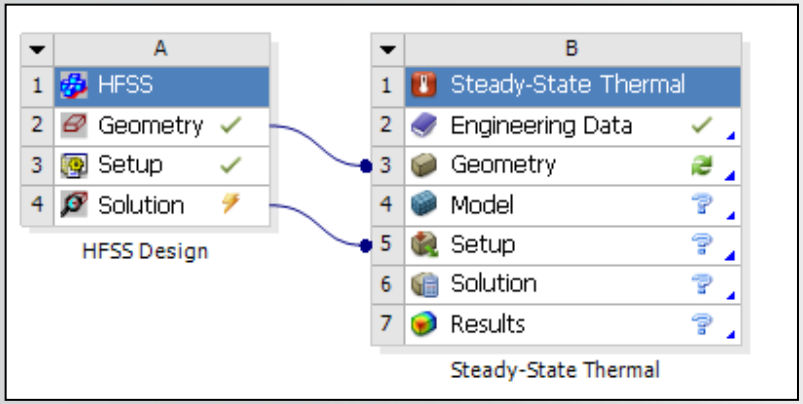
Parameter Set
- Controls inputs and views outputs of each simulation, i.e. Input = Antenna Scan Angle, Output = Max Radome Deformation

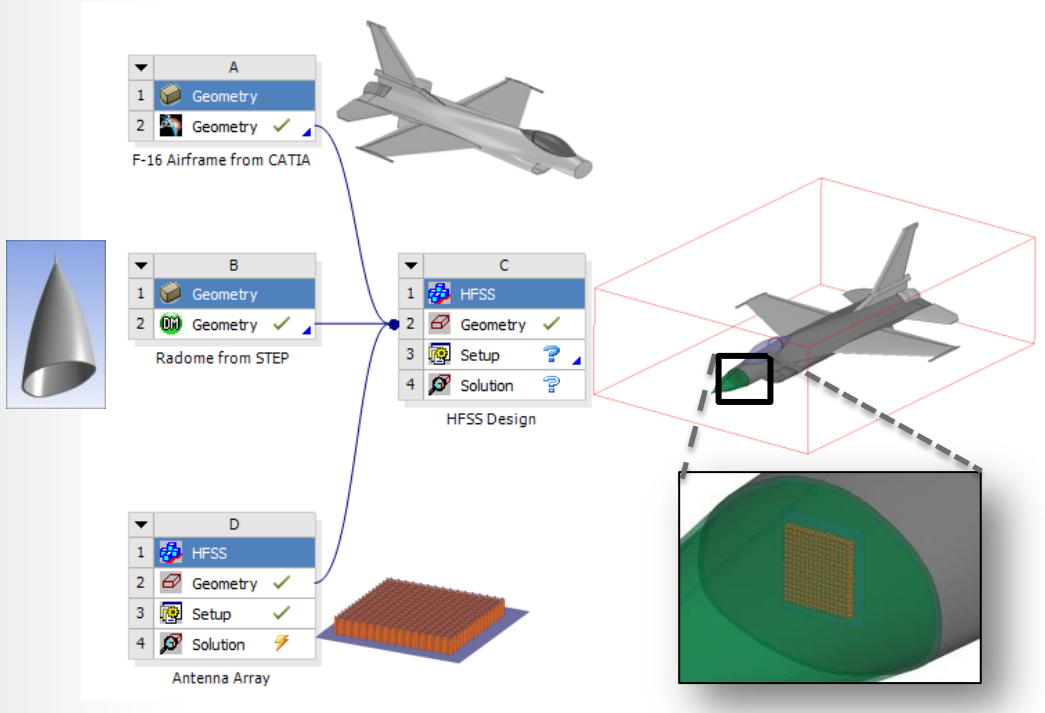
Design Exploration

Ansys Workbench Integration Benefits

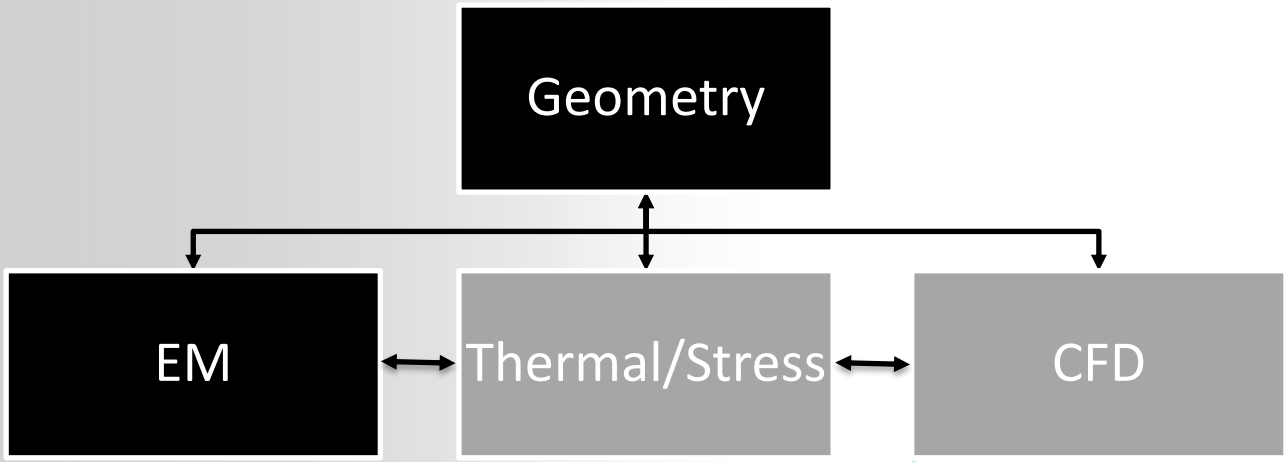
Benefits of Integration

- Utilizes intuitive multi-physics layout
  - Automated data exchange
  - Coupled physics solutions
- Efficient system design exploration
- Streamlined geometry handling
  - CAD integration in ANSYS Workbench provides bi-directional link to 3rd party CAD tools
  - Multiple physics can share the common geometry

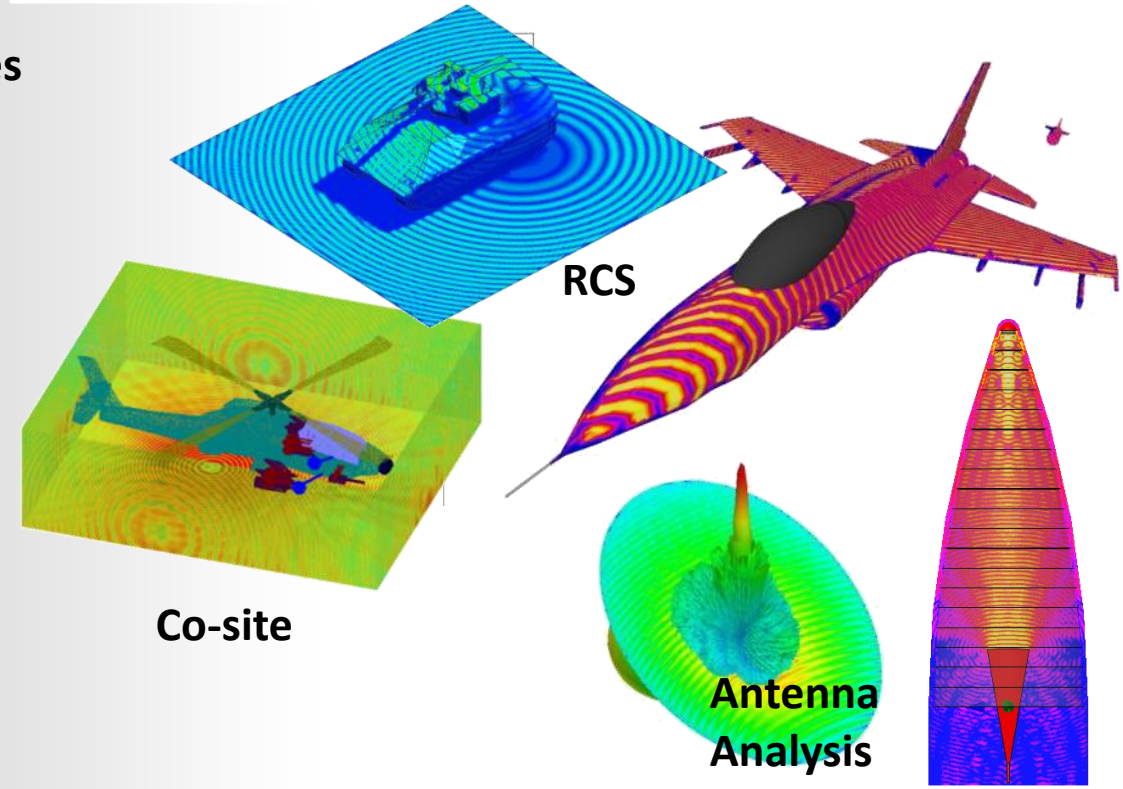




Electromagnetic Solutions

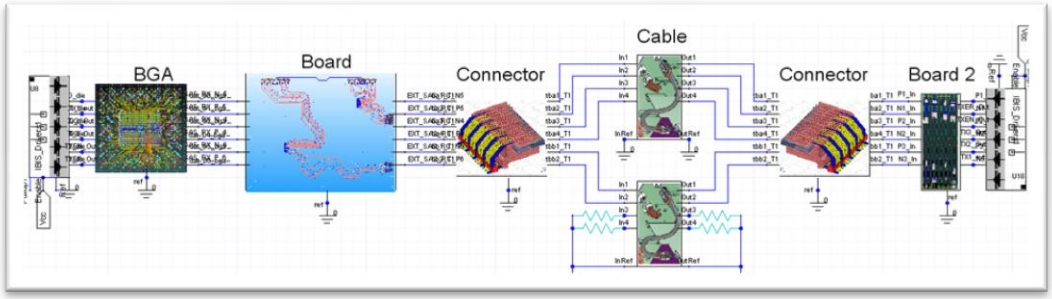


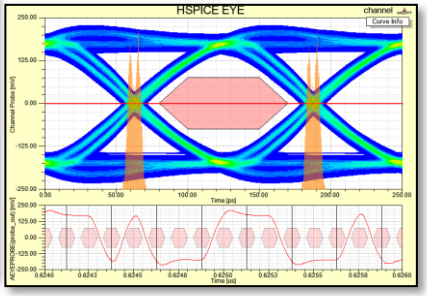
- **Overview ANSYS EM Capabilities**
  - **FEM, IE, PO, hybrid solvers**
  - **RCS**
  - **Antenna Placement/Co-Site Analysis**
  - **Antenna Array**
    - **Unit Cell and Finite Array Analysis**
    - **Array Platform Analysis**
  - **Feed Network**



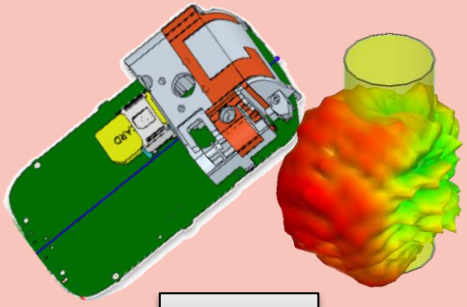
Electronics Applications

Circuit & System Design

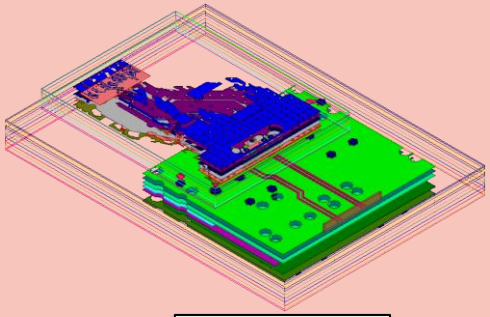




RF and SI Physical Design



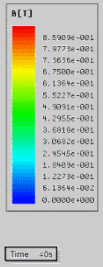
Antennas

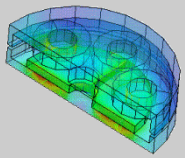


Package/PCB

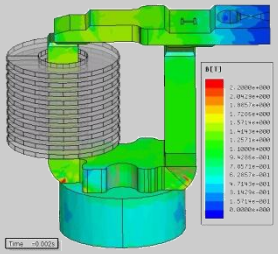
EMI/EMC

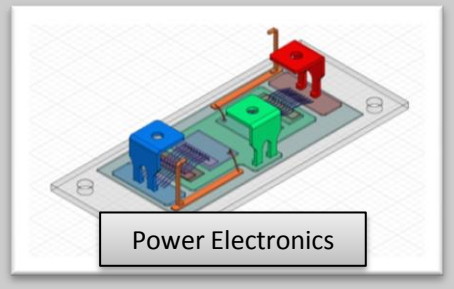
Electromechanical Design





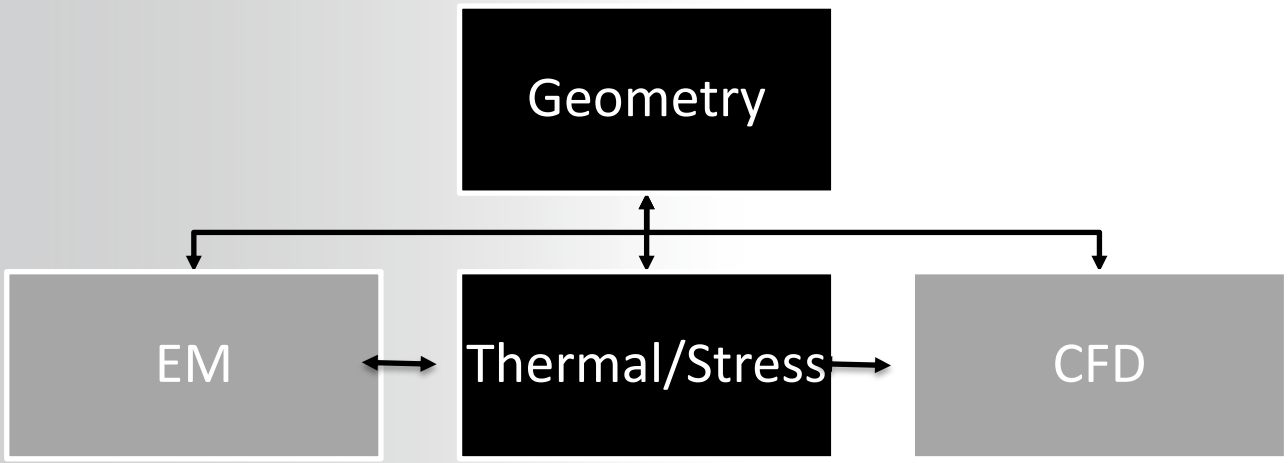
Motors/Actuators



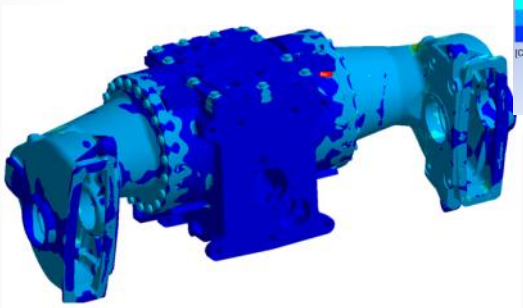


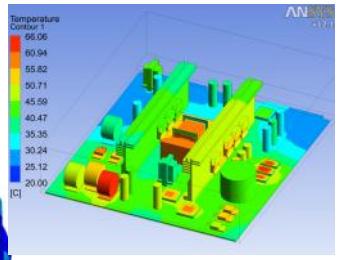
Power Electronics

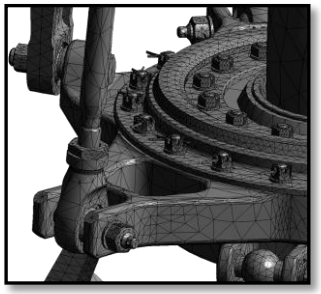
Mechanical Solutions

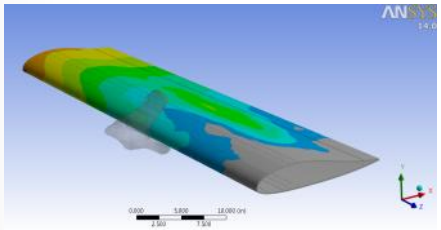


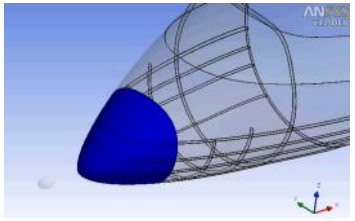
- **Overview ANSYS Mechanical Capabilities**
  - **Steady State/Transient**
  - **Explicit Solvers (Impact)**
  - **Solid, Shell, Beam, and Point Mass Elements**
  - **Convection/Conduction/Radiation/Advection**
  - **Layered Composite Shells and Solids**
  - **Automatic Contact Setup (Thermal and Structural)**
  - **HPC for large model support**



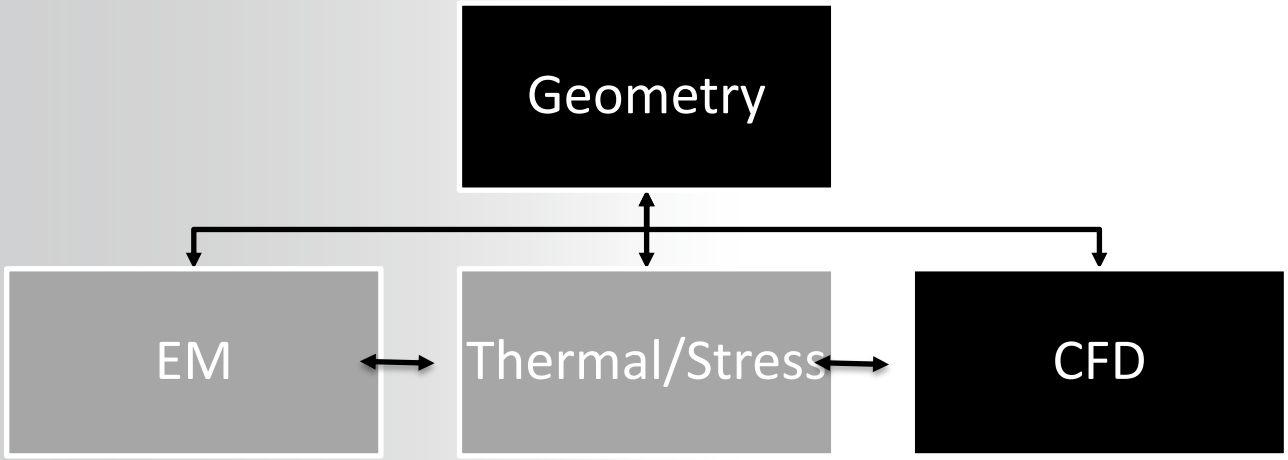




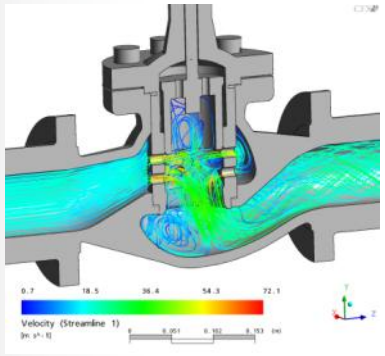


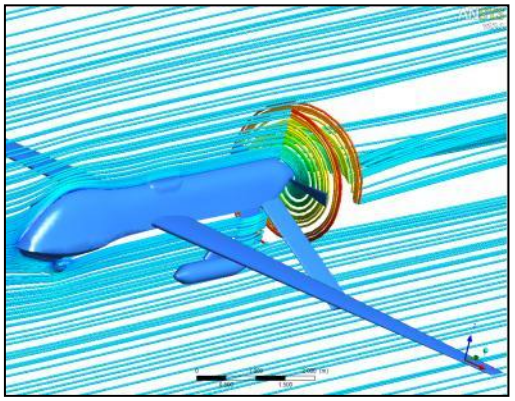


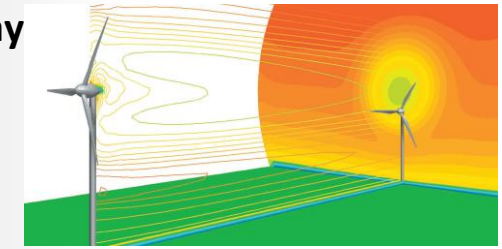
Computational Fluid Dynamics Solutions

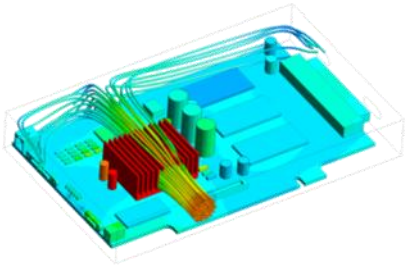


- **Overview of CFD Capabilities**
  - **Incompressible/Compressible Flow**
  - **Extensive Turbulence Models**
  - **Multi-Species & Reacting Flow**
  - **Conjugate Heat Transfer**
  - **Fluid Structure Interaction – 1 way & 2 way**
  - **Dynamic, moving & sliding meshes**

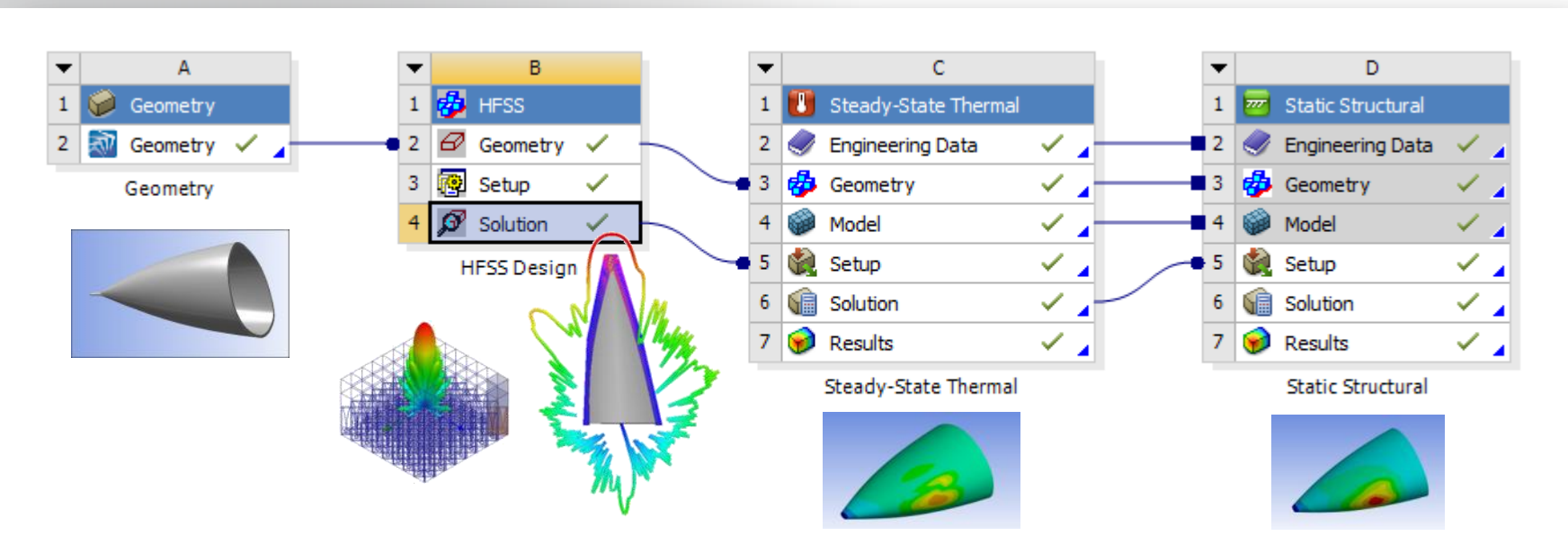








Radome and Antenna Multi-Physics Example: Workbench Project



Geometry

- **Bi-Directional Link to most CAD tools**
- Radome geometry from CAD can be used for all physics

EM Analysis

- **HFSS**
- Data link antenna pattern and Radome

Thermal Analysis

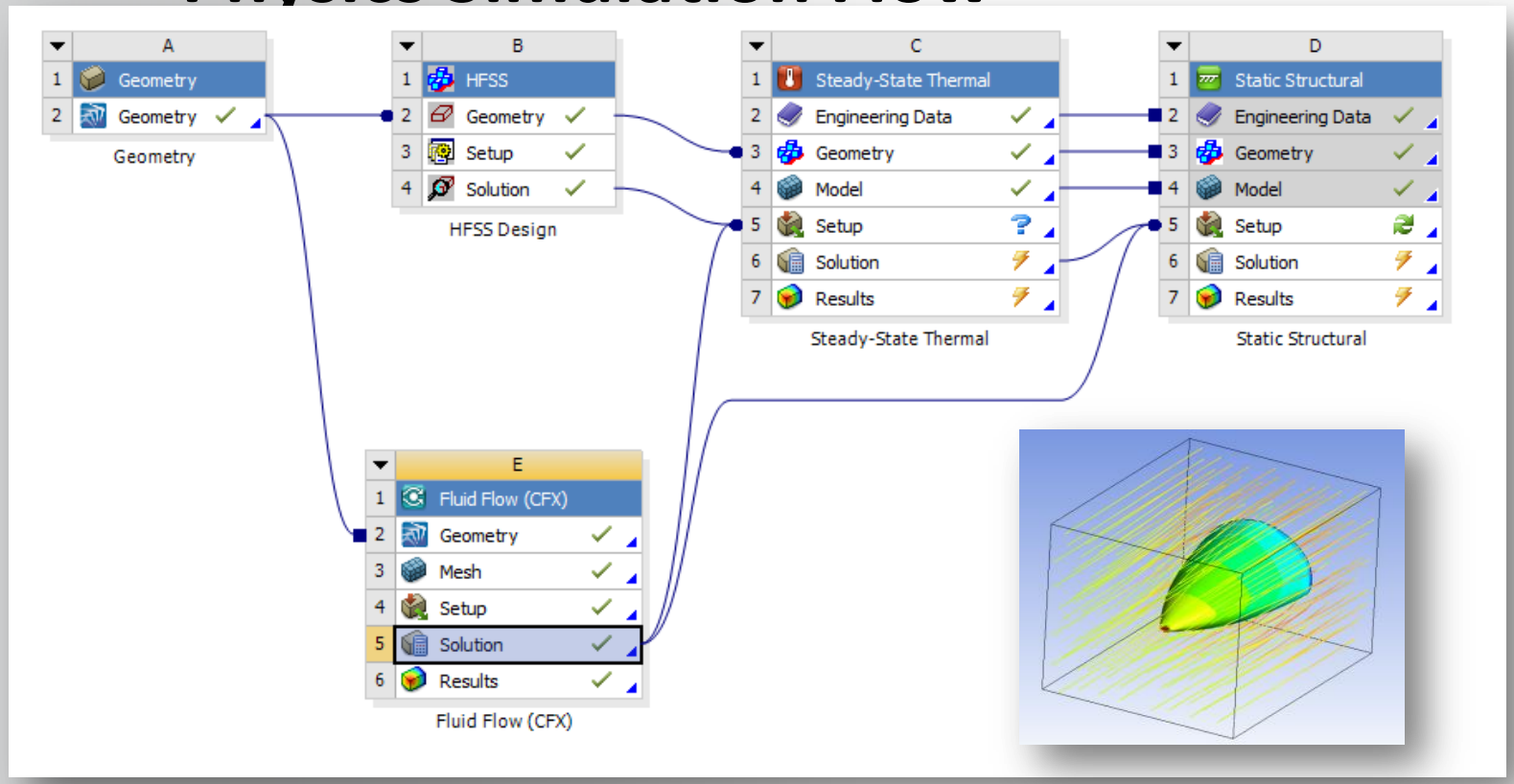
- **Ansys Mechanical**
- Boundary conditions for convection and other thermal properties applied

Structural Analysis

- **Ansys Mechanical**
- Structural boundary conditions and any external loads can be added

Generic geometry source: http://www.3dcontentcentral.com/parts/browse/Aircraft/User-Library/136/136/Models/part.aspx?id=12463#1

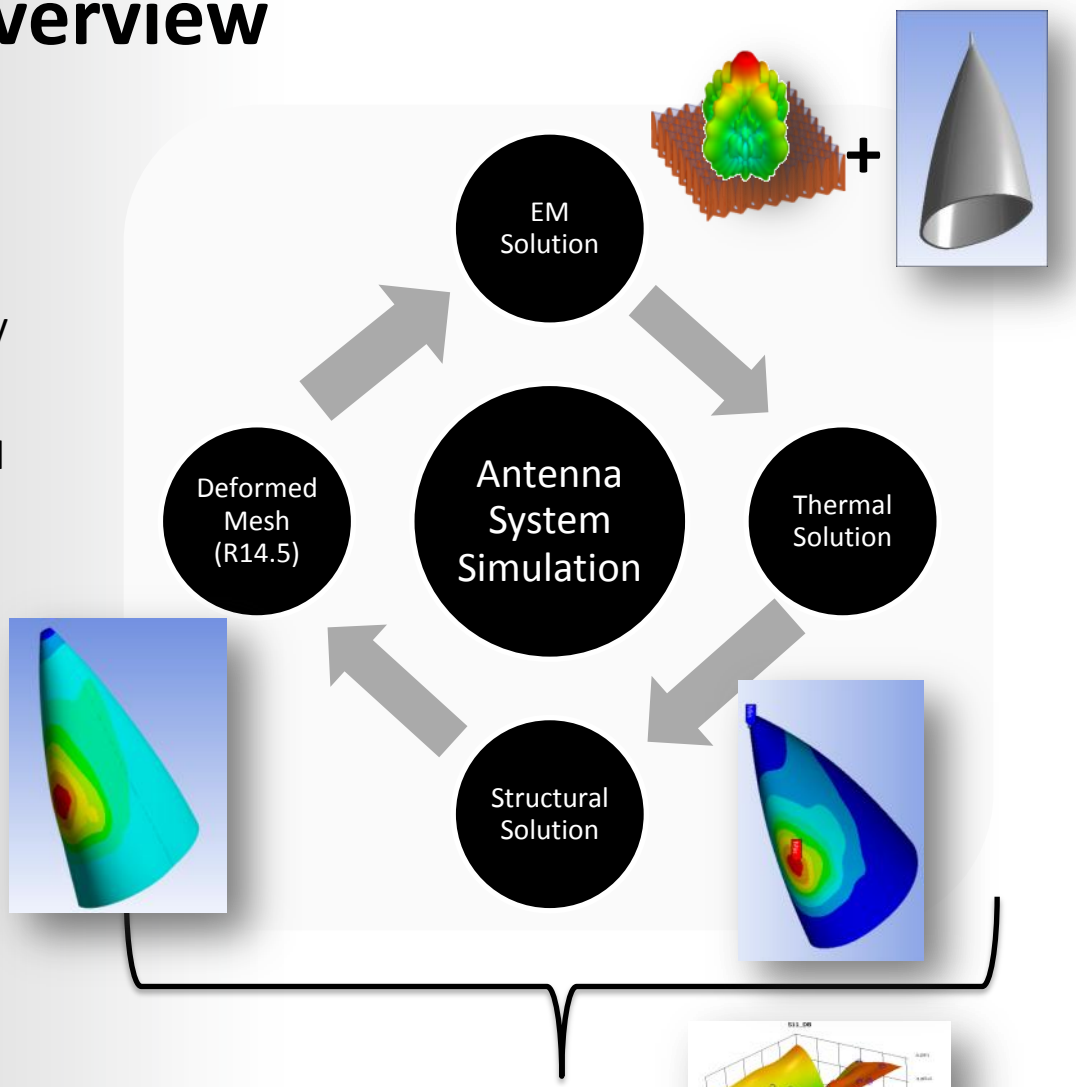
Incorporating Fluid Dynamics into Multi-Physics Simulation Flow



Steady State Thermal and CFD -
Convection coefficients determined from CFD solution
Static Structural and CFD –
Pressure/forces mapped from CFD solution impacting geometry deformation

Simulation Flow – HFSS/Thermal/Stress Simulation Overview

- **Antenna and Radome Simulation Flow**
  - EM Solution of Antenna Array
  - EM Solution of Radome using array solution as excitation (data link)
  - Losses passed to Ansys Mechanical for thermal analysis
  - Thermal loading applied to structural solution to calculate deformation
- **Antenna System Simulation Iterations**
  - Temperature Dependent Material properties can be applied in EM solution
  - Mesh Deformations (v14.5)



Design Exploration
-DOE Based Response Surface
-6σ, Optimization, Statistics

Using Workbench for Design Exploration

DesignXplorer (DX) is a tool for designing and understanding the analysis response of parts and assemblies

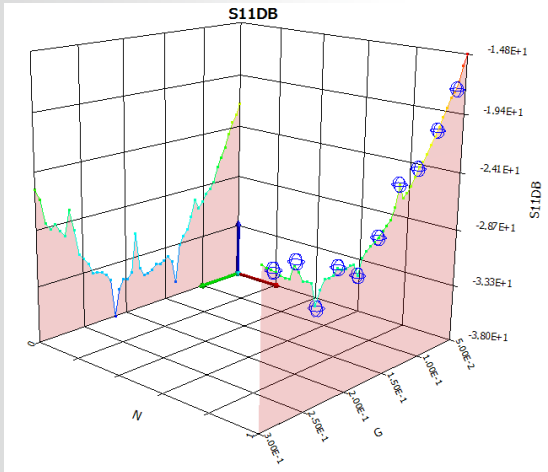
The Response Surface Method allows for optimization and six-sigma studies efficiently

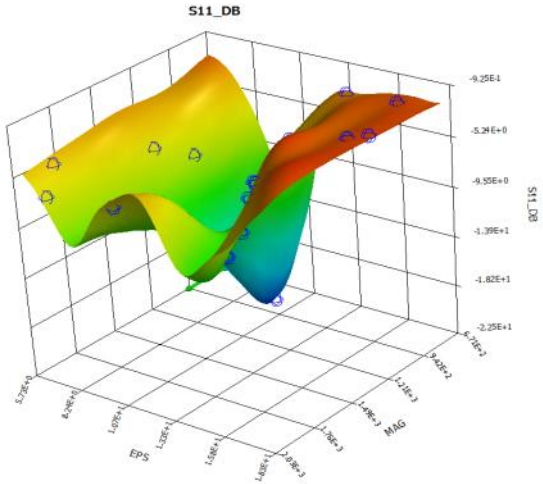
DX uses Design of Experiments (DOE)

- DOE method determines how many, and which, design points should be solved for the most efficient approach to optimization
- Response surface is fit to solved DOE

	B
1	Goal Driven Optimization
2	Design of Experiments
3	Response Surface
4	Optimization

	B
1	Six Sigma Analysis
2	Design of Experiments (SSA)
3	Response Surface (SSA)
4	Six Sigma Analysis

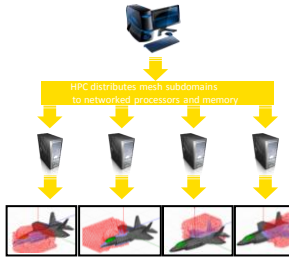


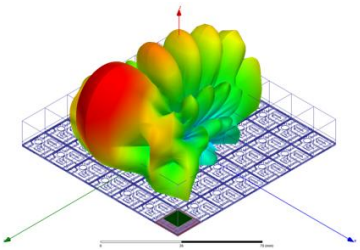


ANSYS High Performance Computing

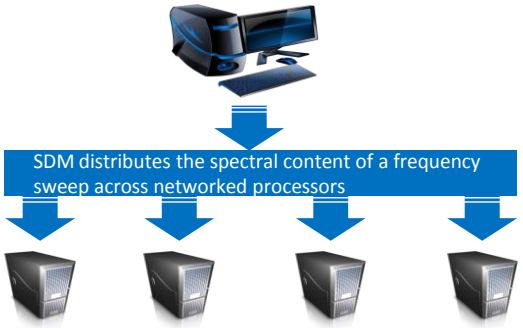
- DSO – Distributed Solve Option

- DDM – Domain Decomposition Method
  - Feature of HPC licensing





- SDM – Spectral Decomposition Method
  - Feature of HPC licensing



- MPO – Multi-processing option
  - Feature of HPC licensing

Further information:

Explore our solutions for electronic simulation: www.ansys.com/Products

Follow us on social media: www.ansys.com/Social@ANSYS

Watch out for webinars supporting robust electronic system design:

www.ansys.com/About+ANSYS/Events