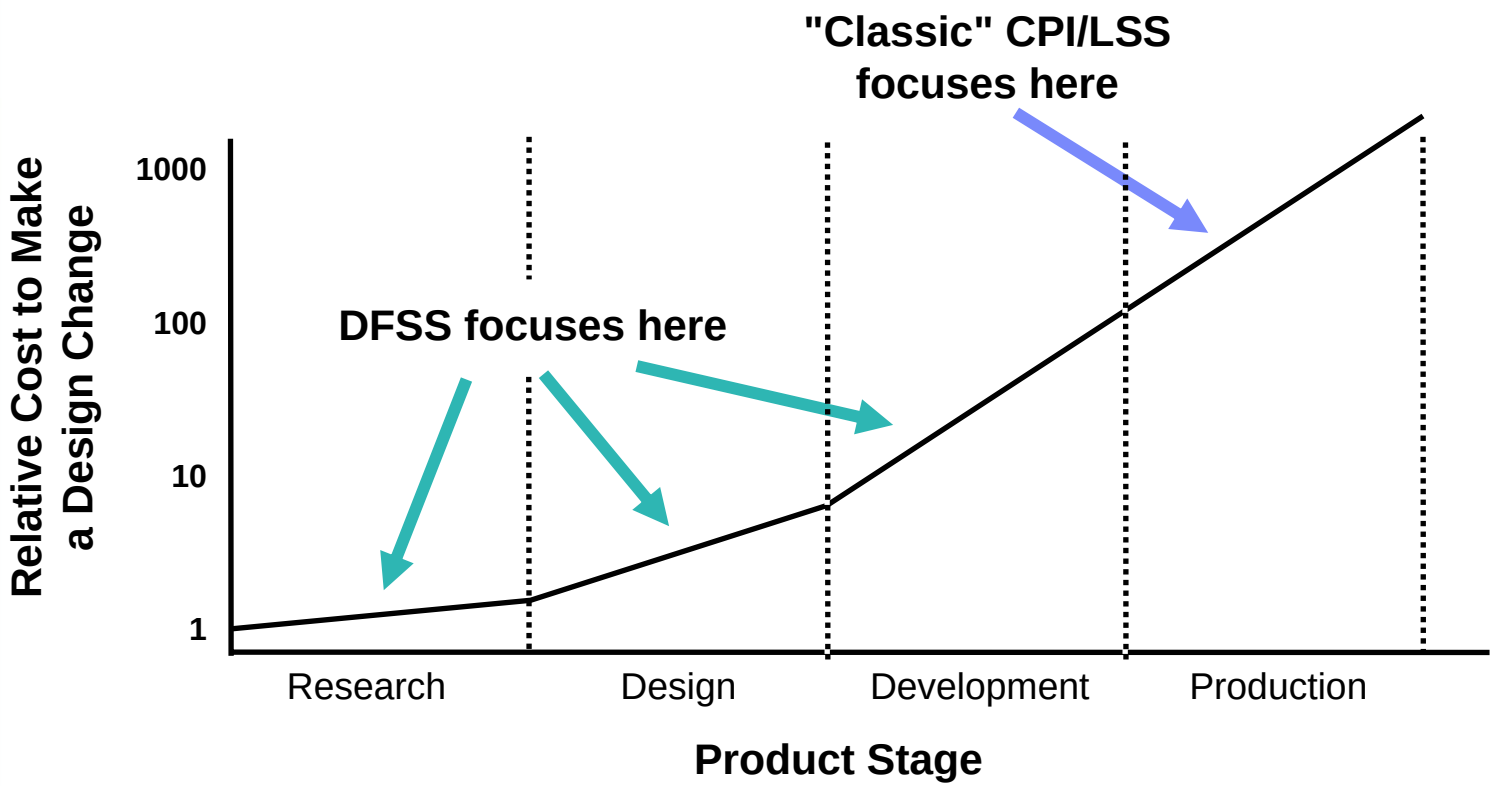
Major Conference Themes/Issues wrt Improving T&E Efficiency and M&S

- OT&E should be validation testing, not discovery testing
- Mission Based Test and Evaluation
- Integrated Testing
- Eliminate failures prior to test
- Unreliability is a design issue
- Put the “E” back into T & E
- First 15% of investment will determine or dictate the remaining 85% of LCC.
- Want exit criteria from one phase to another
- Need to predict performance before we build or test

AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat

Design for Breakthrough Improvement (DFBI*)



- Gain knowledge when costs are lowest
- Design in quality right from the start

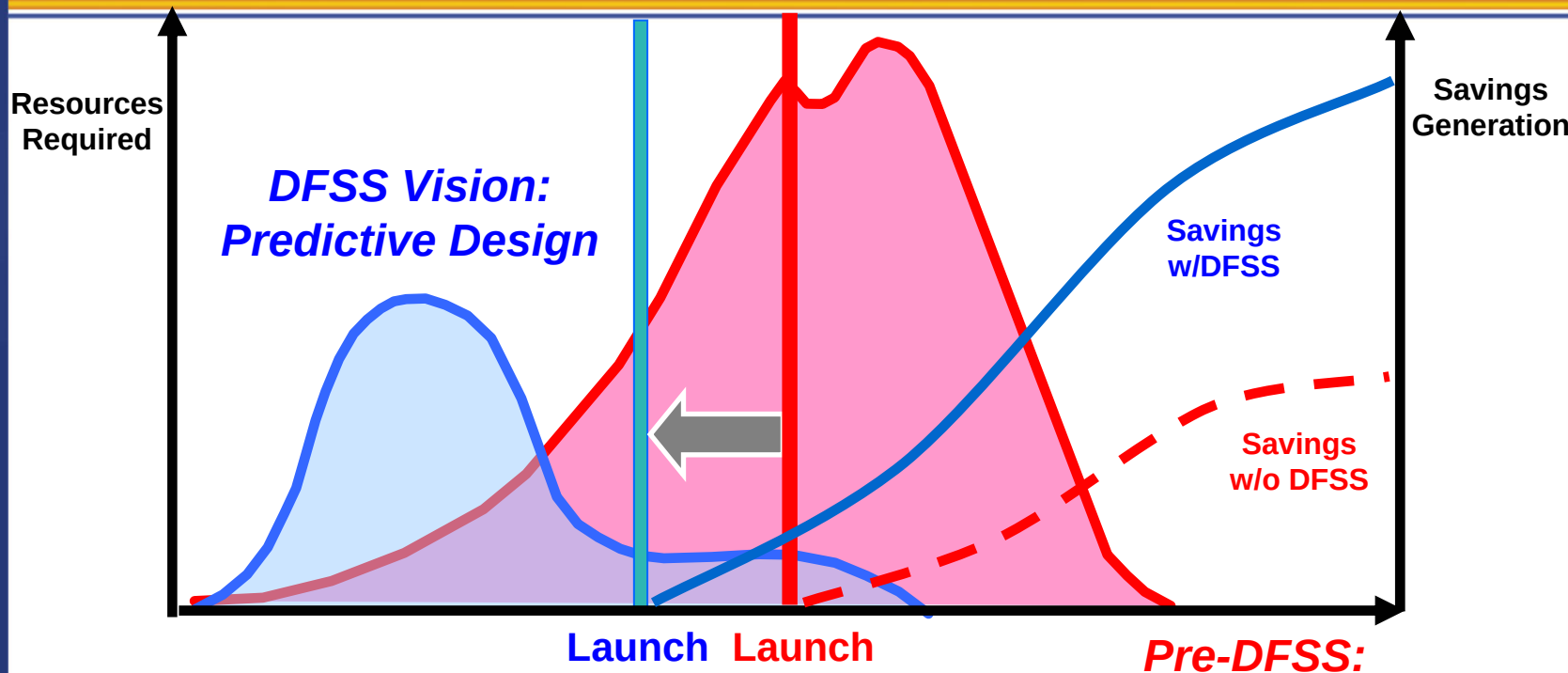
*also known as Design for Six Sigma (DFSS)

Air Academy Associates
Simplify, Perfect, Innovate

DFBI or DFSS Goals

- ***Reduce Cycle Time in the Design and Development Process***
- ***Reduce the total resources and cost over the life cycle***
- ***Reduce the Cost of Poor Quality***
- ***Improve Predictability of QCD (Quality, Cost, Delivery)***

The Benefits



- Early problem identification; solution when costs low
- Faster market entry: earlier revenue stream, longer patent coverage
- Lower total development cost
- Robust product at market entry: delighted customers
- Resources available for next game-changer

Pre-DFSS: Reactive Design

- Unhappy customers and employees
- Unplanned resource drain
- Skyrocketing costs
- Next product compromised

- **Upfront investment is most effective and efficient**
- **Show customers "high quality" products right from the start**

Air Academy Associates

Simplify, Perfect, Innovat

The Vision

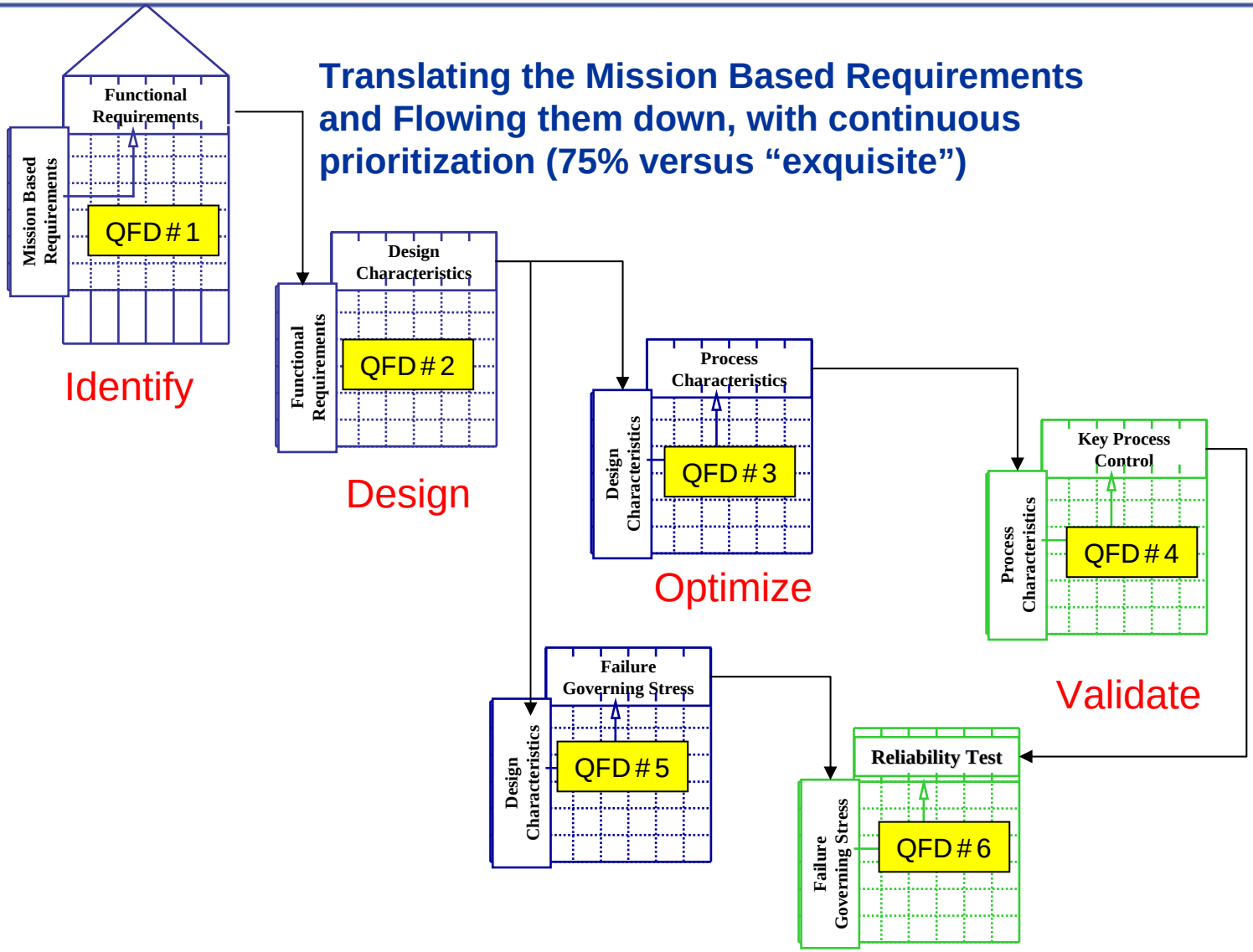
From
- Evolving design requirements
- Extensive design rework
- Product performance assessed by "build and test"
- Performance and producibility problems fixed <u>after</u> product in use
- Quality "tested in"

To
- Disciplined CTC flowdown
- Controlled design parameters
- Product performance modeled and simulated
- <u>Designed</u> for robust performance and producibility
- Quality "designed in"

- Lean Six Sigma (DMAIC) fixes known problems.
- ***DFBI or DFSS prevents unknown problems from occurring.***

Air Academy Associates
Simplify, Perfect, Innovat

Quality Function Deployment (QFD)



AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat

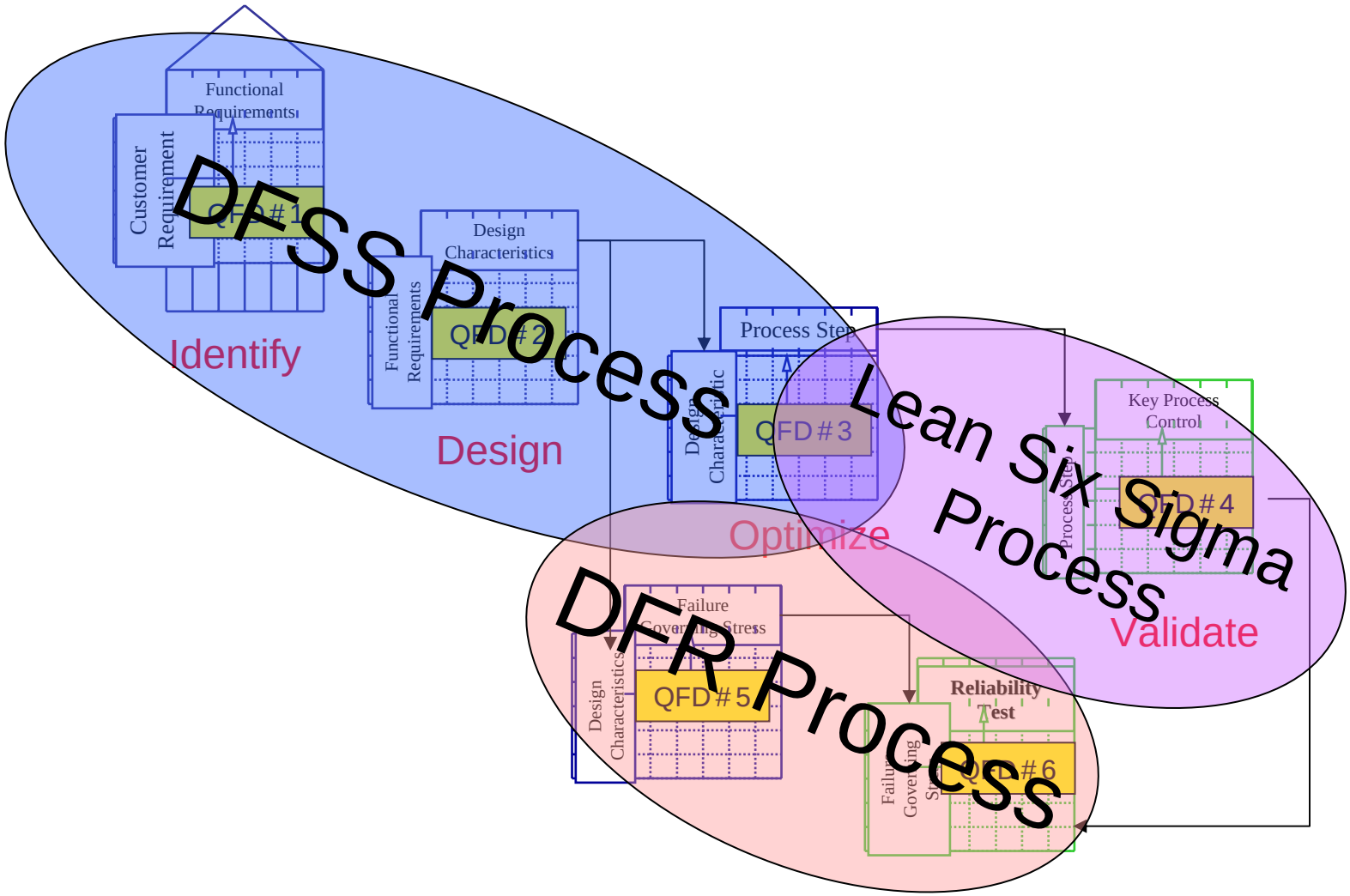
Background – MBT&E Overview

Mission-Based Test and Evaluation

is a methodology that focuses T&E on the mission task **capabilities** provided to the warfighter. It provides a *framework* and *procedure* to:

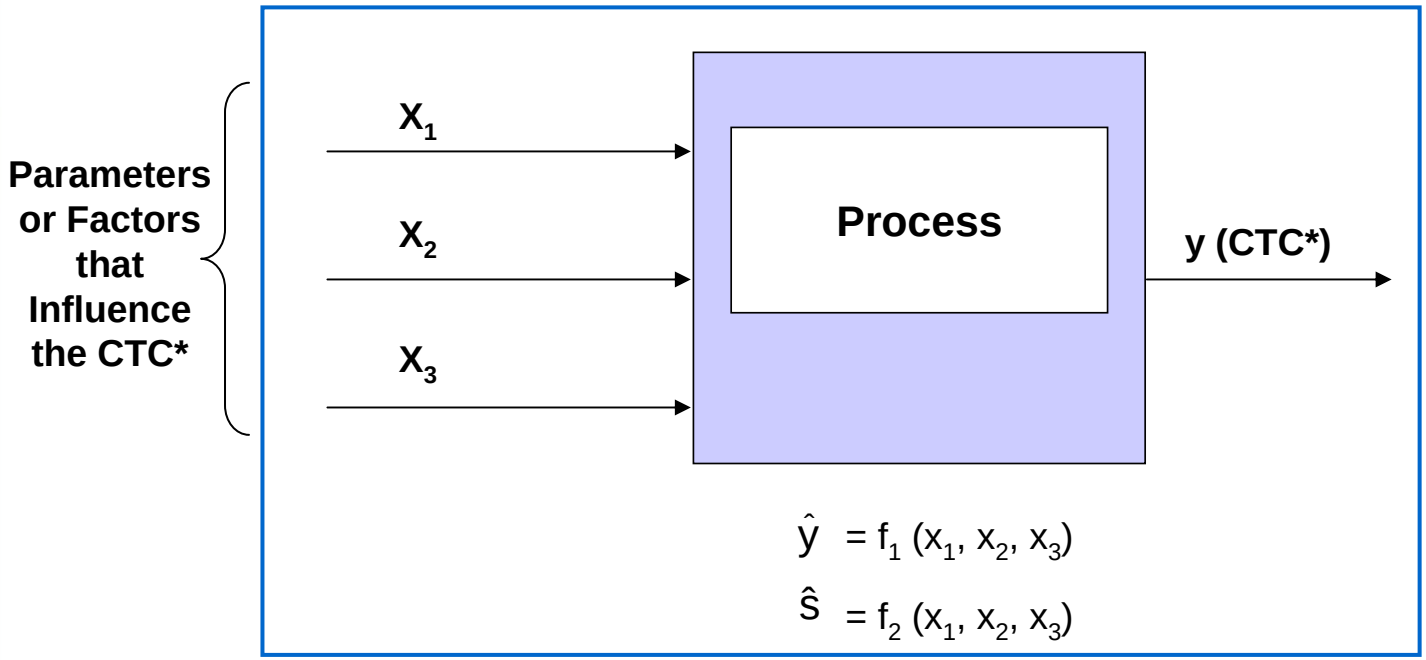
- **link capabilities to the attributes** of the materiel system-of-systems;
- develop evaluation measures that **assess capabilities and attributes**;
- and link the evaluation measures to all **available data sources**.

Linking DFSS, LSS, and DFR in the QFD Flowdown



Simplify, Perfect, Innovat

Transfer Function: The Bridge to Innovation



Where does the transfer function come from?

- **Exact transfer Function**
- **Approximations**
  - **DOE (also known as Multi-Variate Testing)**
  - **Historical Data Analysis**
  - **Simulation**

*** Critical to Customer (or Functional) Performance Measure**

Design of Experiments (DOE) and Integrated Testing

"Integrated testing is the collaborative planning and collaborative execution of test phases and events to provide shared data in support of independent analysis, evaluation and reporting by all stakeholders, particularly developmental (both contractor and government) and operational test and evaluation communities."

AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat

Design of Experiments (DOE) and Integrated Testing

"Integrated testing is the collaborative planning and collaborative execution of test phases and events to provide shared data in support of ***independent*** analysis, ***evaluation*** and reporting by all stakeholders, particularly developmental (both contractor and government) and operational test and evaluation communities."

AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat

What Makes DOE so Powerful? (Orthogonality: both vertical and horizontal balance)

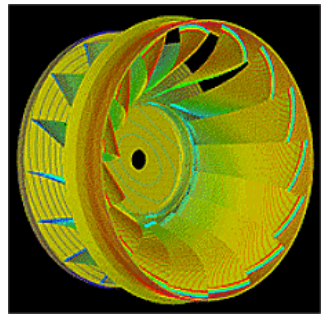
A Full Factorial Design for 3 Factors A, B, and C, Each at 2 levels:

Run	A	B	C	AB	AC	BC	ABC
1	-	-	-	+	+	+	-
2	-	-	+	+	-	-	+
3	-	+	-	-	+	-	+
4	-	+	+	-	-	+	-
5	+	-	-	-	-	+	+
6	+	-	+	-	+	-	-
7	+	+	-	+	-	-	-
8	+	+	+	+	+	+	+

Air Academy Associates
Simplify, Perfect, Innovat

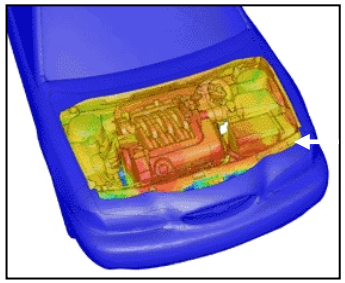
Applications of Modeling and Simulation

Power



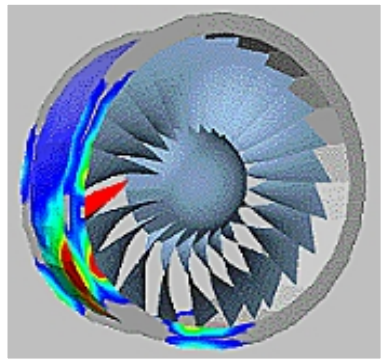
Simulation of stress and vibrations of turbine assembly for use in nuclear power generation

Automotive



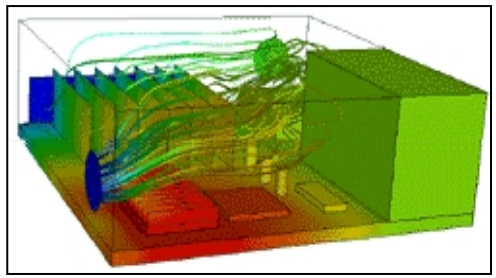
Simulation of underhood thermal cooling for decrease in engine space and increase in cabin space and comfort

Aerospace



Evaluation of dual bird-strike on aircraft engine nacelle for turbine blade containment studies

Electronics



Evaluation of cooling air flow behavior inside a computer system chassis

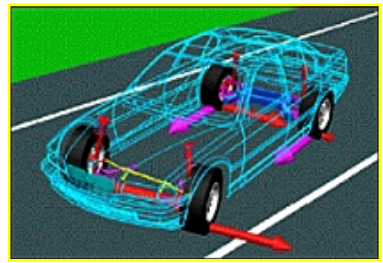
AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat

Examples of Computer Aided Engineering (CAE) and Simulation Software

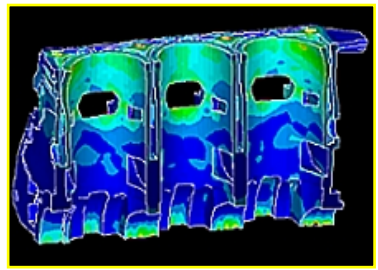
Mechanical motion: Multibody kinetics and dynamics

- ADAMS®
- DADS



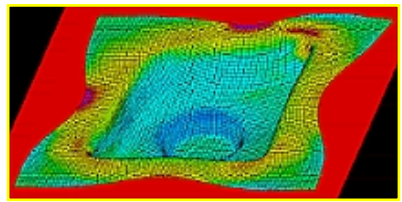
Implicit Finite Element Analysis: Linear and nonlinear statics, dynamic response

- MSC.Nastran™, MSC.Marc™
- ANSYS®
- Pro MECHANICA
- ABAQUS® Standard and Explicit
- ADINA



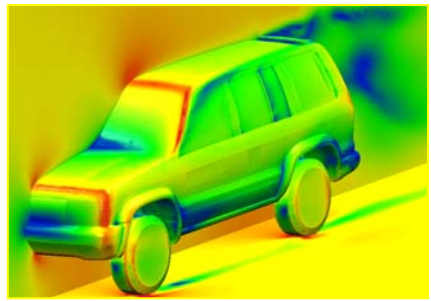
Explicit Finite Element Analysis : Impact simulation, metal forming

- LS-DYNA
- RADIOSS
- PAM-CRASH®, PAM-STAMP



General Computational Fluid Dynamics: Internal and external flow simulation

- STAR-CD
- CFX-4, CFX-5
- FLUENT®, FIDAP™
- PowerFLOW®



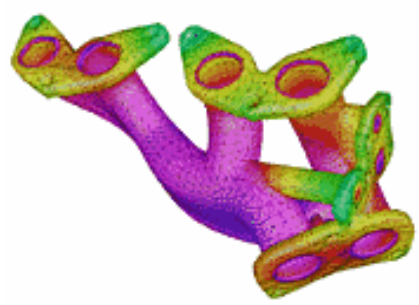
AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat

Examples of High Fidelity Simulation Models

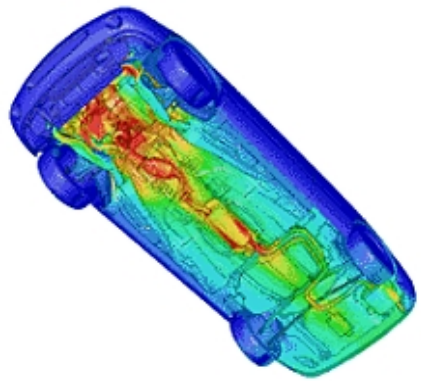
Preprocessing: Finite Element Analysis and Computational Fluid Dynamics mesh generation

- ICEM-CFD
- Gridgen
- Altair® HyperMesh®
- I-deas®
- MSC.Patran
- TrueGrid®
- GridPro
- FEMB
- ANSA



Postprocessing: Finite Element Analysis and Computational Fluid Dynamics results visualization

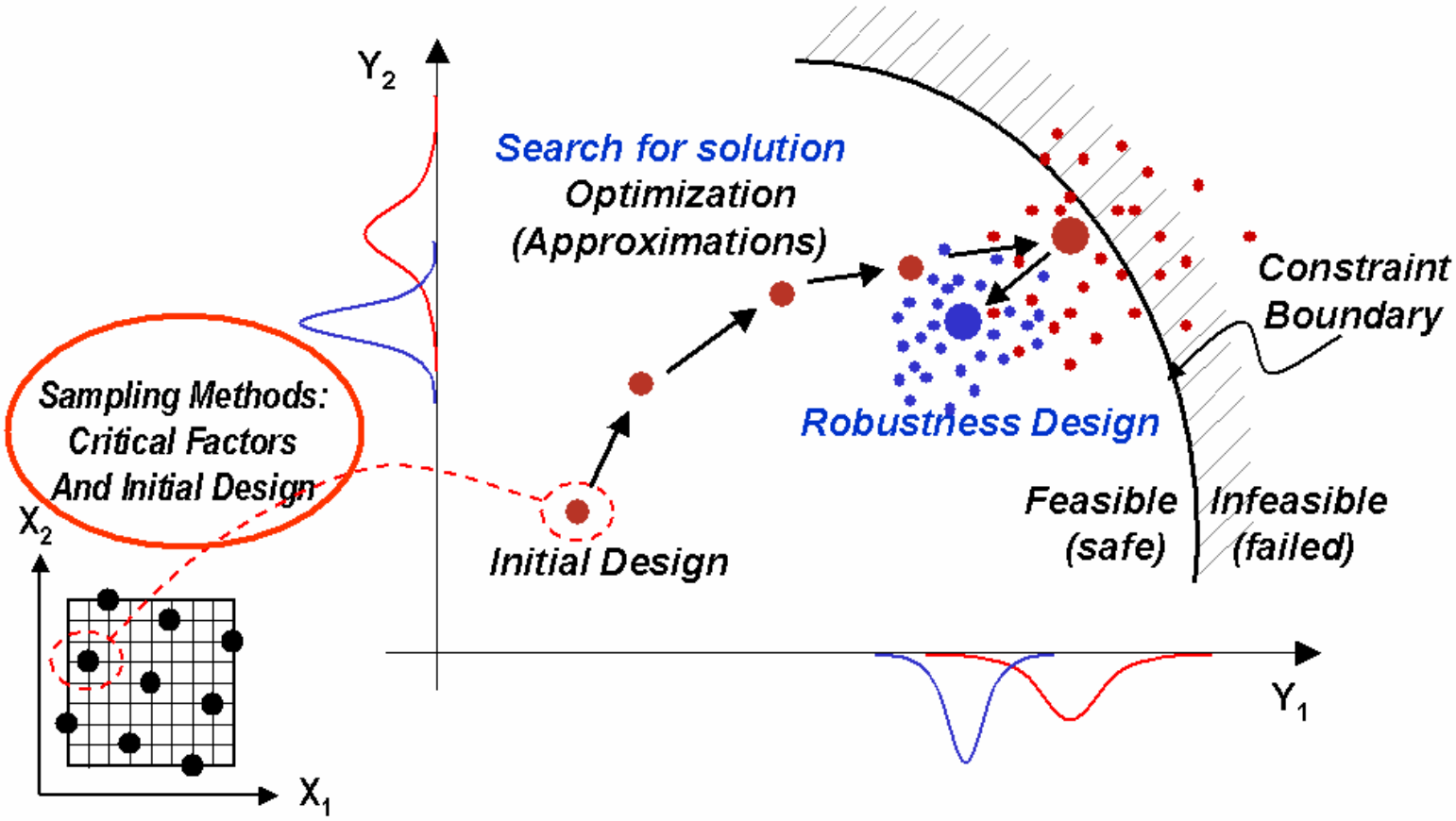
- Altair® HyperMesh®
- I-deas
- MSC.Patran
- FEMB
- EnSight
- FIELDVIEW
- ICEM CFD Visual3 2.0 (PVS)
- COVISE



AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat

Making Use of Iterative Simulation and Modeling for Optimizing the Design



AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat

Knowledge Based Principles*

- Develop a Product Development System Built Upon Knowledge
- Focus on Knowledge Generation to Streamline the Product Development Process, Rather Than Strict Adherence to Pre-determined Timelines
- Move from schedule-driven acquisition to knowledge-driven acquisition
- Promote Technical Competency Over Procedural Compliance
- Develop Innovation–Driven Project Leaders/Program Managers
- Support and Reward Technical Excellence, Systematic Innovation and Competency

* **These principles are based on the key findings of the Research and Technology Executive Council, as presented in its September 2006 article entitled "*Establishing a Lean R&D Organization*."**

AIR ACADEMY ASSOCIATES

Simplify, Perfect, Innovat