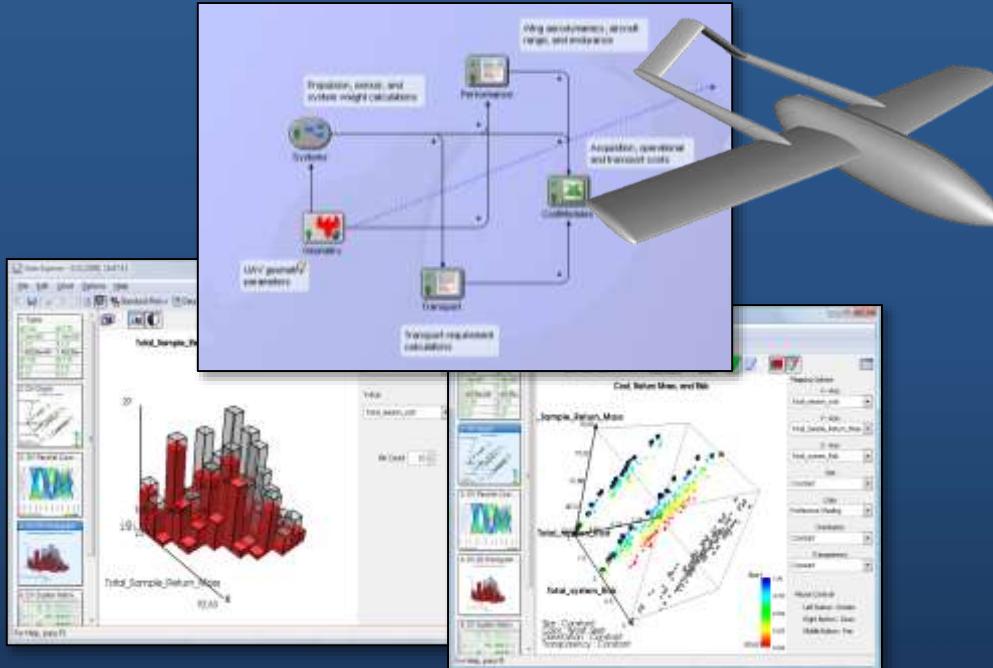


# 프로세스 통합 및 설계최적화 솔루션 ModelCenter® 소개



2016.

로터스정보기술(주)

Leading-edge Optimization Technologies by Unified Simulation

# 목 차

- **ModelCenter Introduction**
- **ModelCenter Case Examples**
- **ModelCenter Cloud Deployment**
- **MBSE Pak Introduction**
- **MBSE Pak Case Examples**
- **LOTUS Technologies, Inc. Introduction**

# Introduction to PHX ModelCenter

# Phoenix Integration, Inc.

- Provide engineering software and services to customers in all industries
- 21 years history
- Evolved out of a research program at Virginia Tech
- Office locations
  - Detroit, MI, USA
  - Blacksburg, VA, USA (Corporate)
  - Toulouse, France
- World-wide partners, services, and sales network



[www.phoenix-int.com](http://www.phoenix-int.com)

**KOREA Distributor**

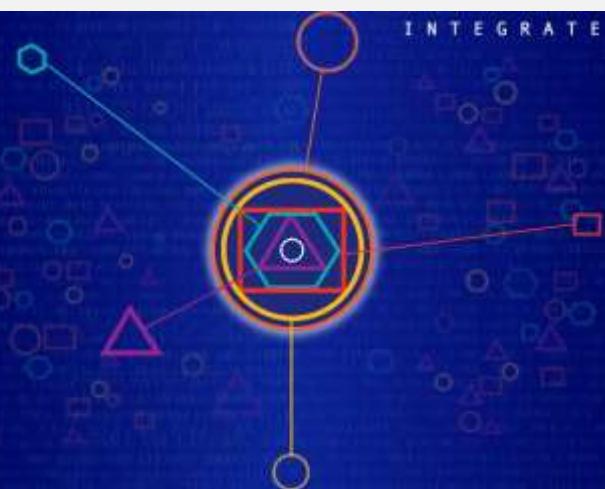


# Phoenix Integration, Inc.



# ModelCenter®

## ModelCenter® Integrate



## ModelCenter® Explore



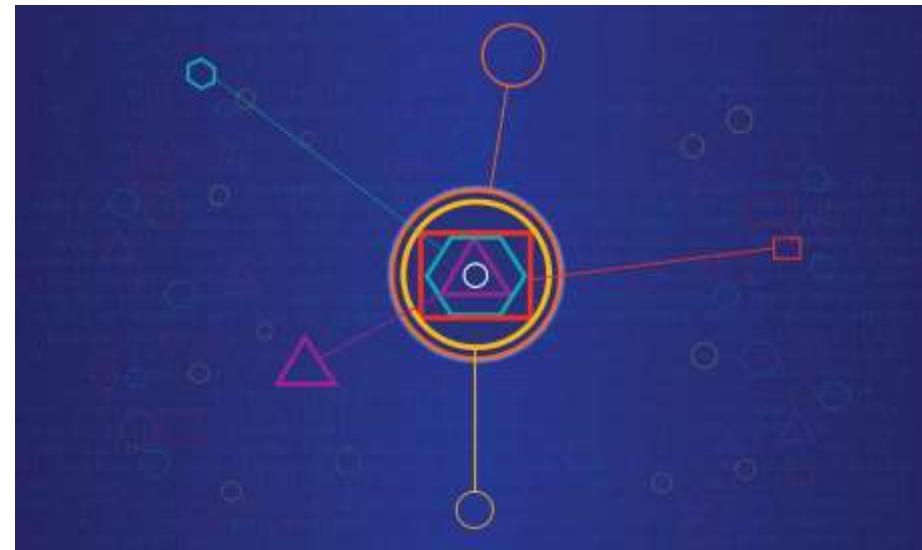
## ModelCenter® Organize



Desktop Deployment  
Cloud Deployment



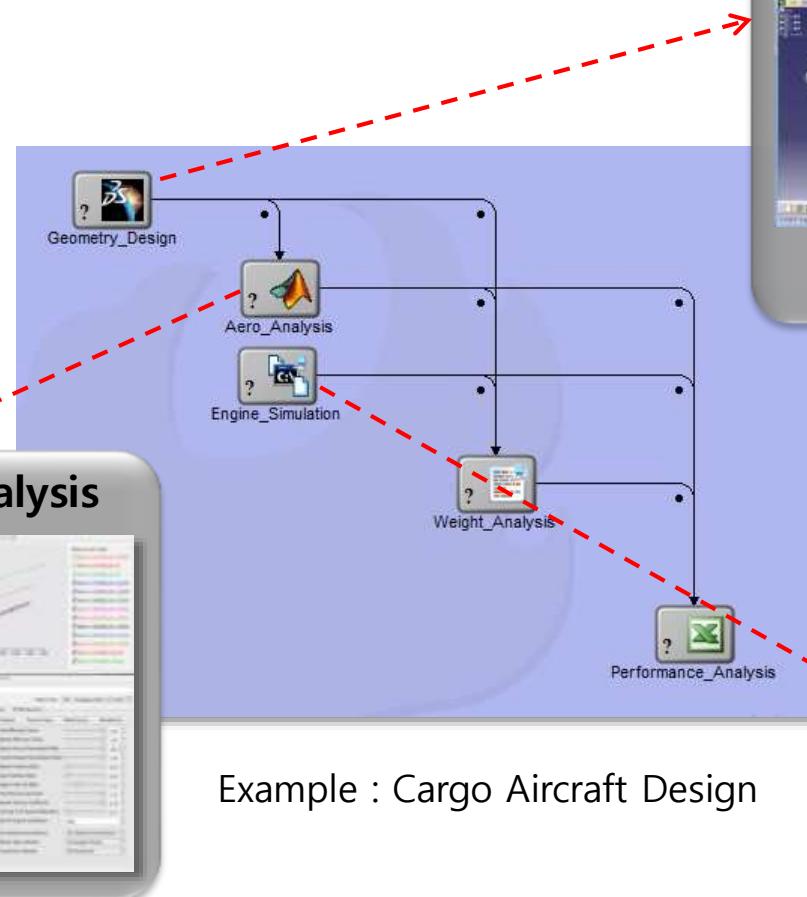
# ModelCenter® Integrate



- **Integrate any simulation tool from any vendor**
- **Create and automate simulation workflows**
- **Set simulation parameters**
- **Run multidisciplinary simulation processes**

# Process Integration and Automation

- **다분야 통합 설계**  
: Multi-disciplinary Design Optimization (MDO)

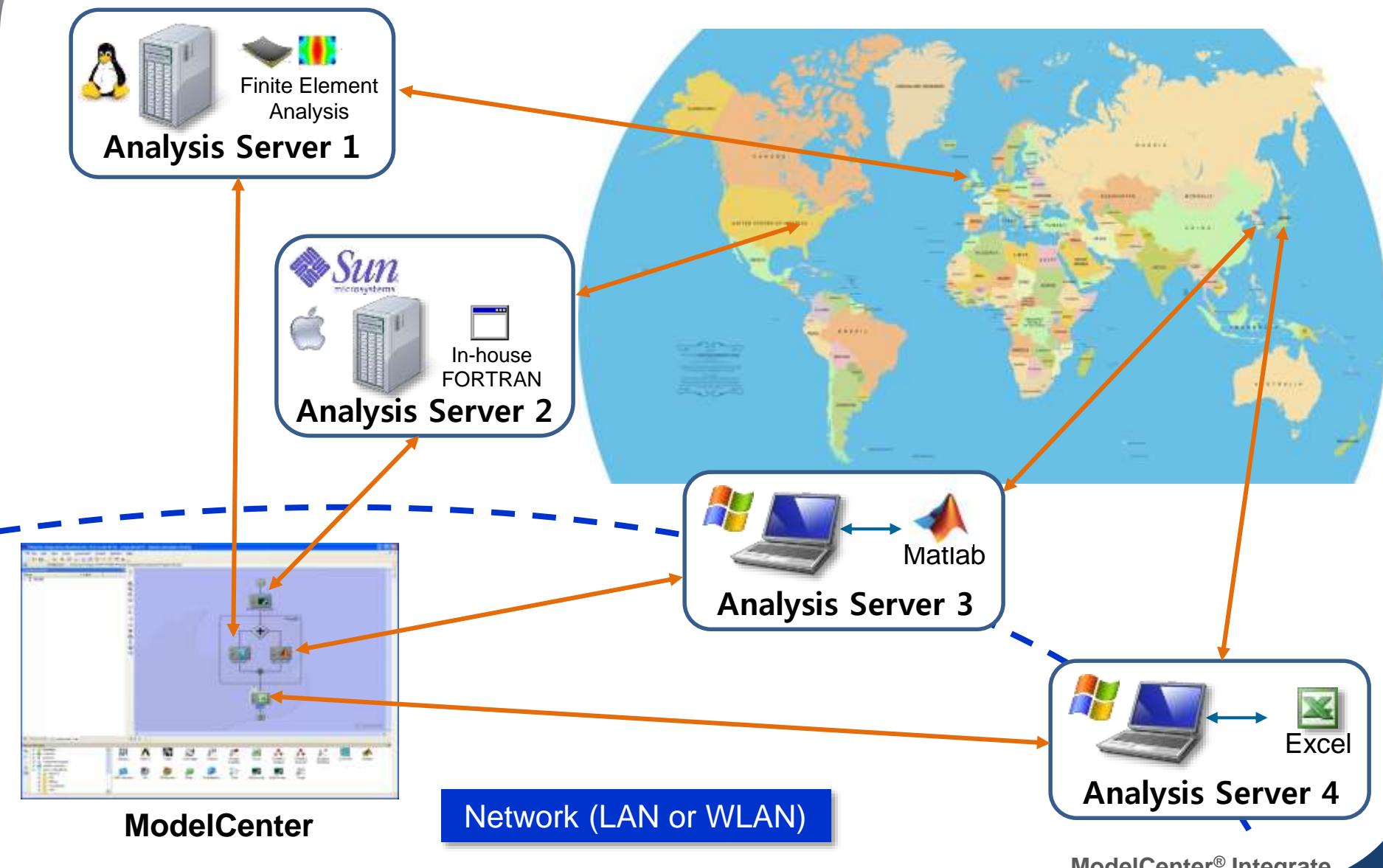


CAD Modeling

Aerodynamic Analysis

Engine Simulation

# How to integrate the Components?



# Modeling and Simulation Tools Integration

- 모델링 & 시뮬레이션 도구 통합

- 다수의 모델링 & 시뮬레이션 도구를 통합할 수 있는 Vendor-Neutral 구조



- Plug-in, Wrapper, API 기능을 이용한 통합
- CAE/CAD 프로그램, In-house 코드, 비용분석 프로그램 등 다양한 도구 및 어플리케이션과의 연동 지원

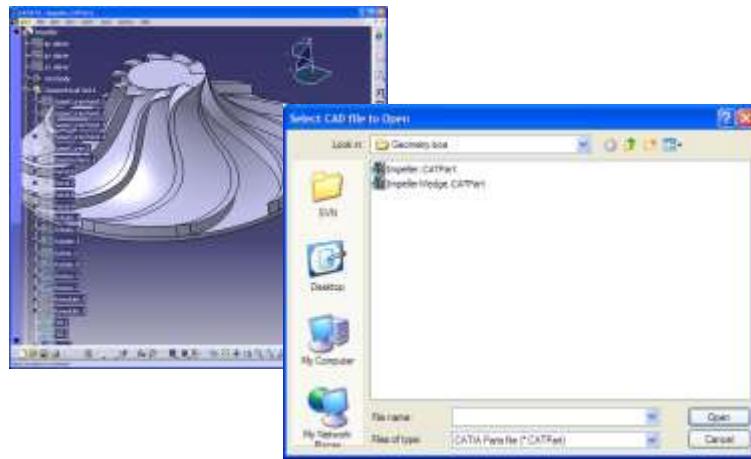


ModelCenter® Integrate

# CAD Integration

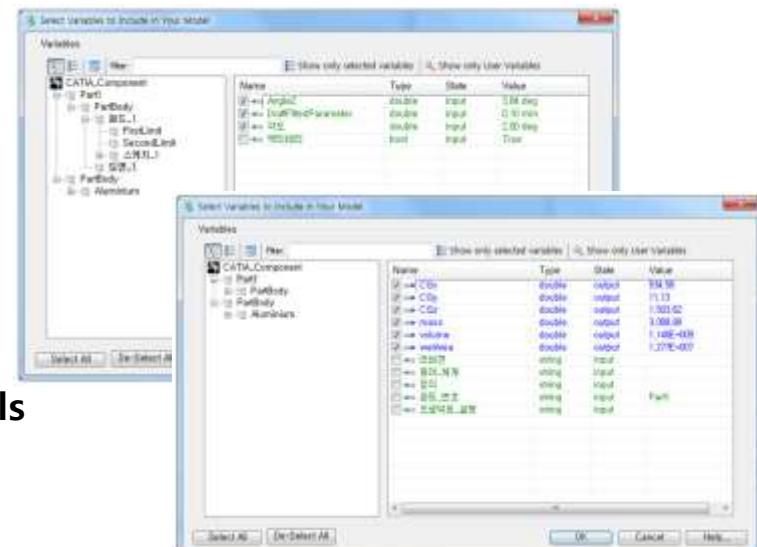
- NX, ProE/Creo, CATIA, OpenVSP, SolidWorks Plug-in

## 1 Select existing part file



## 2 Select input/output variables

- Change any input parameter
- Compute mass, volume, CG
- Export Native CAD format, IGES



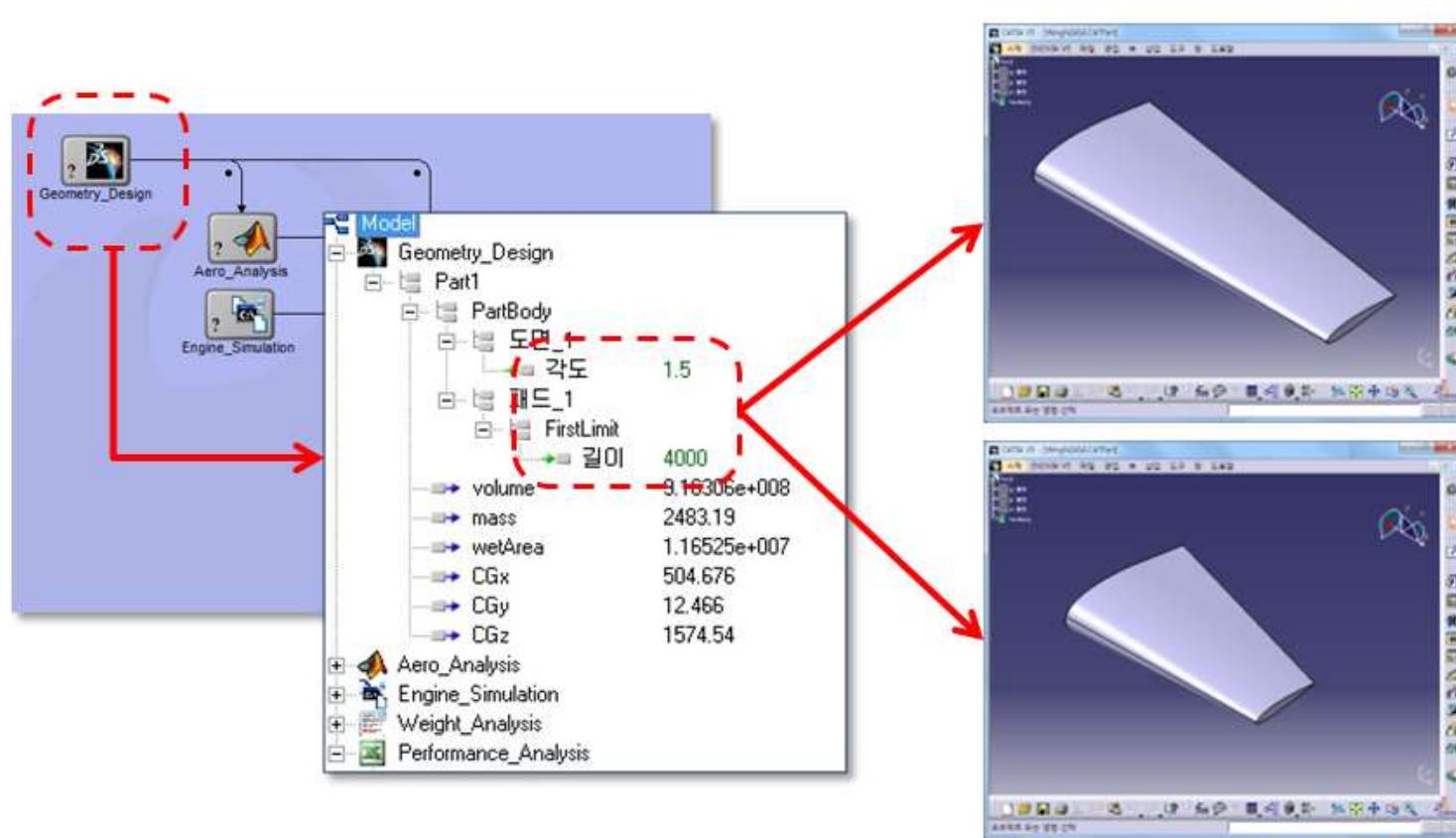
## 3 Add to ModelCenter and integrate with other tools



ModelCenter® Integrate

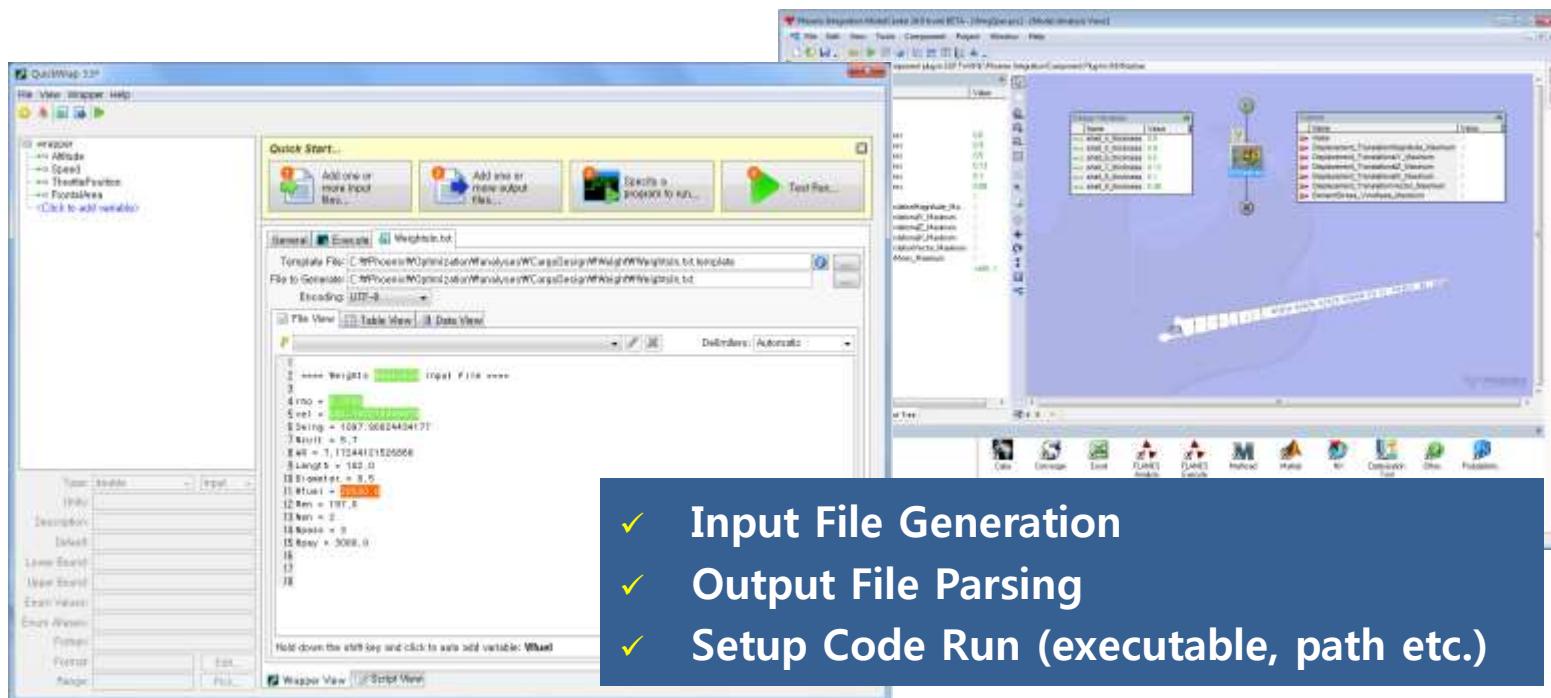
# CAD Integration

- ModelCenter 상에서 형상 설계변수 제어
- 추출한 형상 설계변수와 하위 해석 프로세스 / 파라미터 간 연계



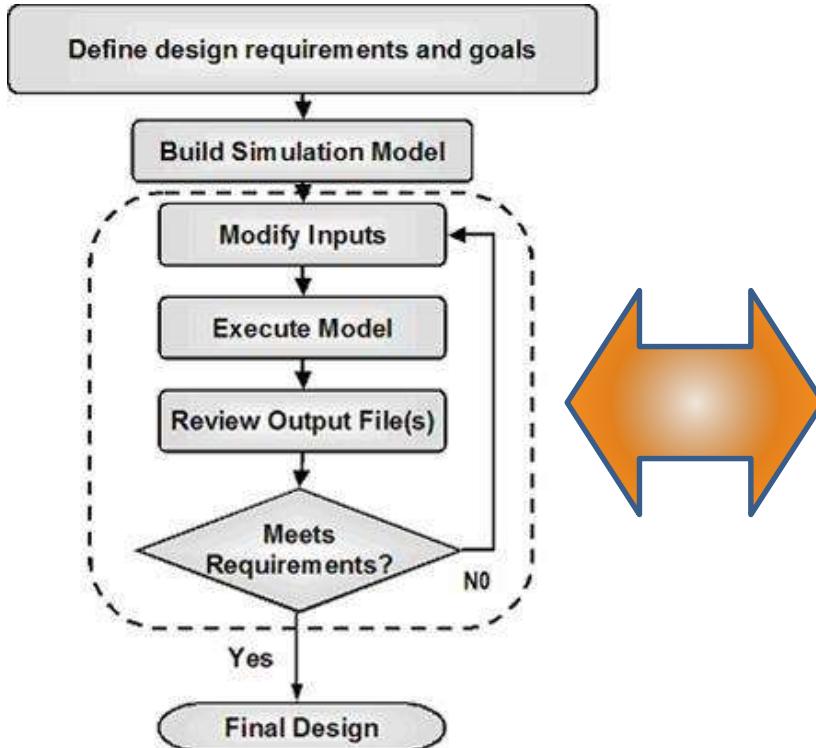
# Process Integration : QuickWrap

- **Quickly Integrate Analysis Tools**
  - Point and Click
  - COTS Tools (Nastran, ANSYS, Abaqus, etc.)
  - Custom/Legacy Tools (FORTRAN, C++, etc.)
  - Anything that Reads and Writes ASCII files



# Process Integration

- 통합 인터페이스
- FileWrapper, ScriptWrapper, 3<sup>rd</sup> Party 컴포넌트 등  
ex) FileWrapper : 파일 In/Out 프로그램에 대한 통합 인터페이스

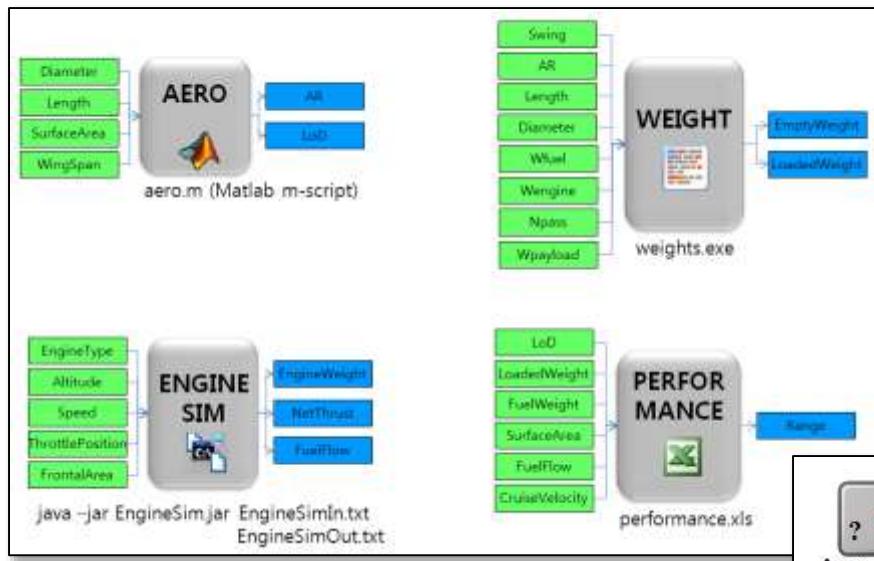


```
# @author: Jay Shim
# @version: 1.0
# @description: Engine Simulation Code FileWrapper
#
RunCommands
{
    generate: EngineIN
    run: "run.bat"
    parse: EngineOUT
}

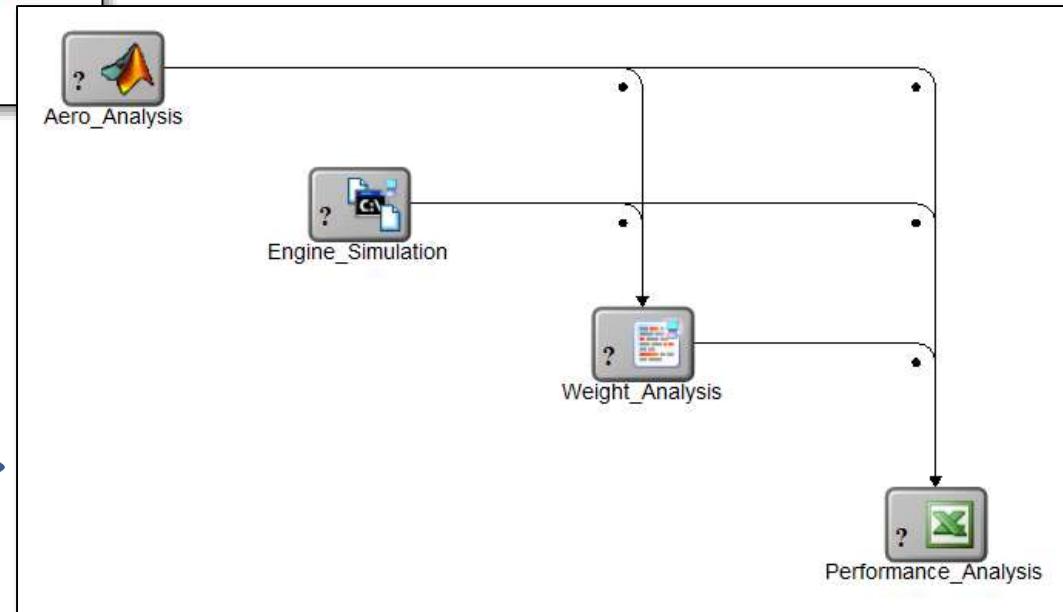
# specify the input file section
RowFieldInputFile: EngineIN
{
    # specify template file and input file
    templateFile: EngineSimIn.txt.template
    fileToGenerate: EngineSimIn.txt
    #
    # Input Variable Mapping
    #
    setDelimiters "==""
    variable: EngineType      string 1 2
    variable: Altitude        double 2 2
    variable: Speed           double 3 2
    variable: ThrottlePosition double 4 2
    variable: FrontalArea     double 5 2
}

RowFieldOutputFile: EngineOUT
{
    # specify the file to parse
    fileToParse: EngineSimOut.txt
    #
    # Output Variable Mapping
    #
    setDelimiters "\t"
    variable: EngineWeight    double 4 1
    variable: NetThrust       double 4 2
    variable: FuelFlow         double 4 3
}
```

# Process Integration



Process Map

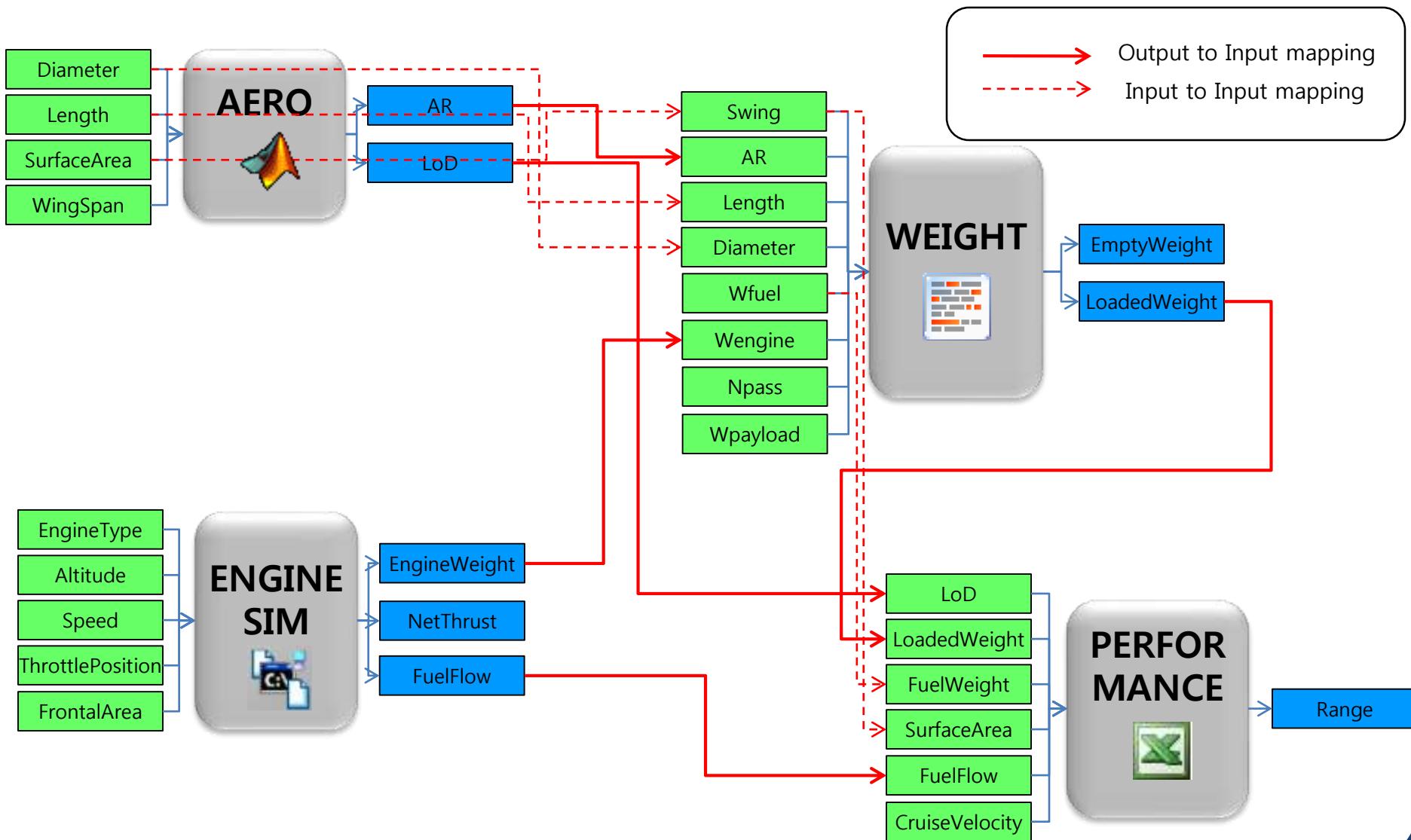


Process Model

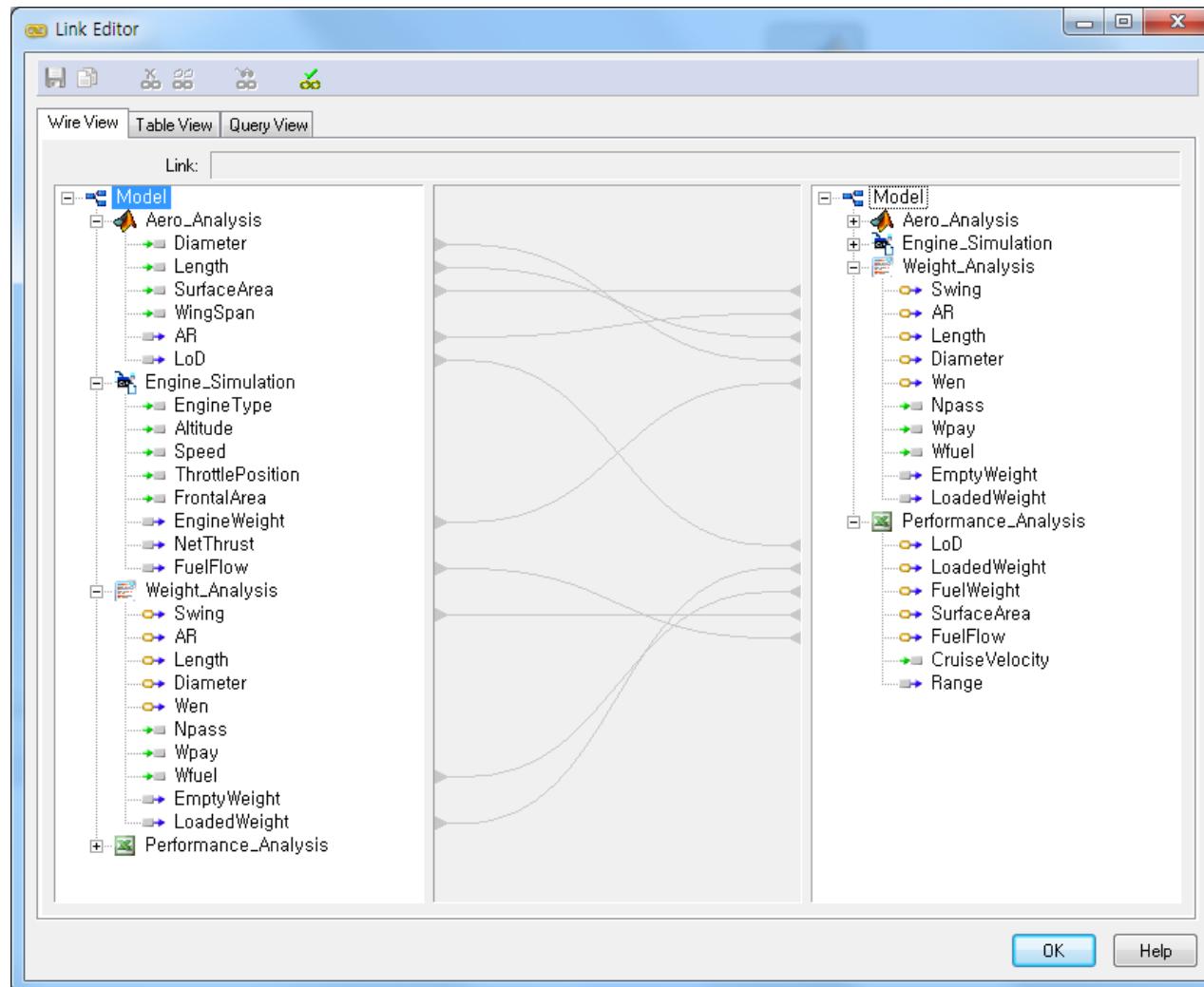
ModelCenter® Integrate

[www.lotustech.co.kr](http://www.lotustech.co.kr)

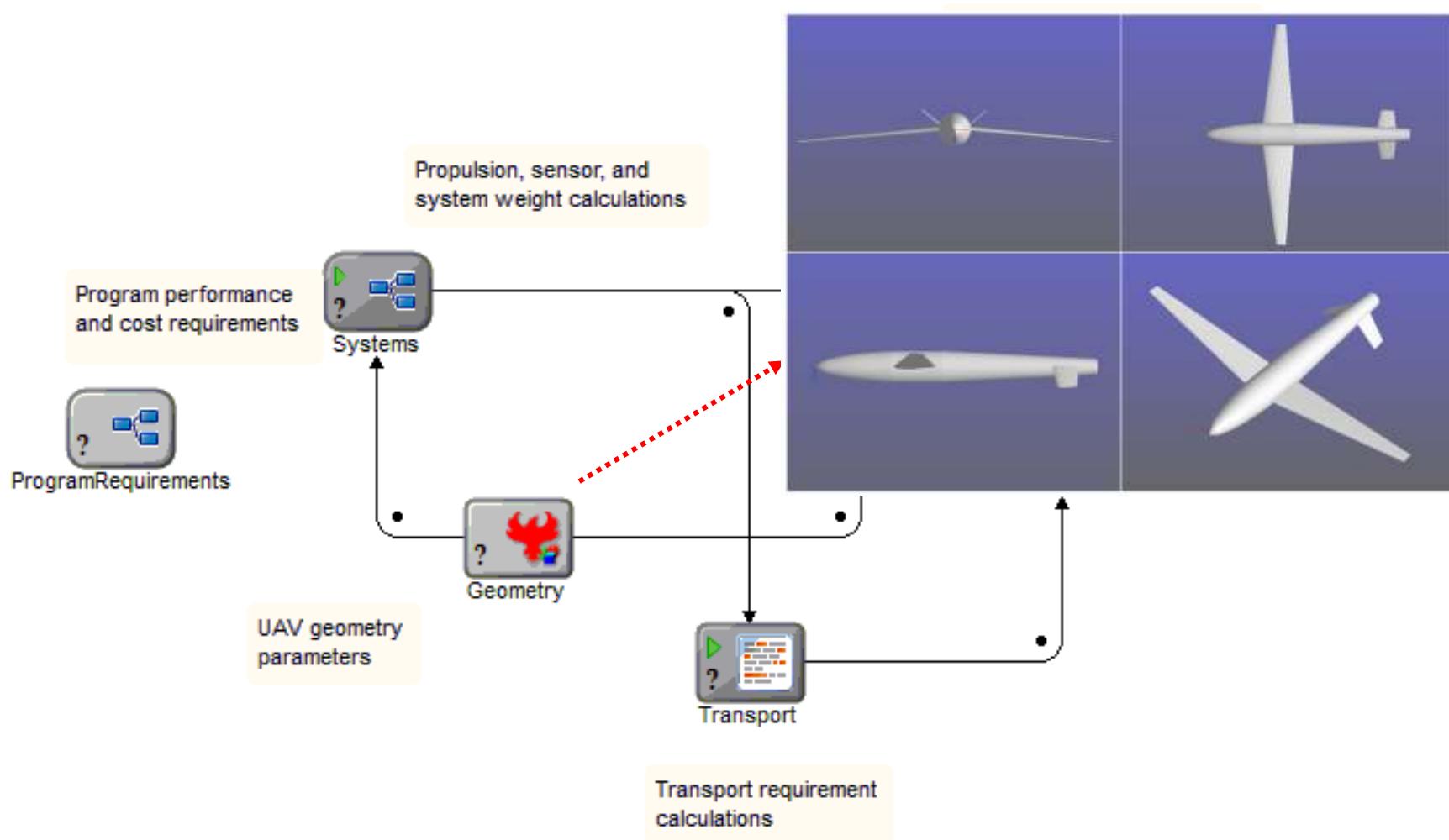
# Parameter Mapping : 설계변수간 연동(Link)



# Parameter Mapping by Link Editor



# 통합 설계 시스템 사례 : UAV Design



- ✓ [ModelCenter Demo : UAV Design\(DOE\)](#)

# ModelCenter® Explore



- Run powerful algorithms and trade-study tools
- Search, investigate, and understand the design space
- Visualize results and the impacts of design changes
- Find optimum solutions

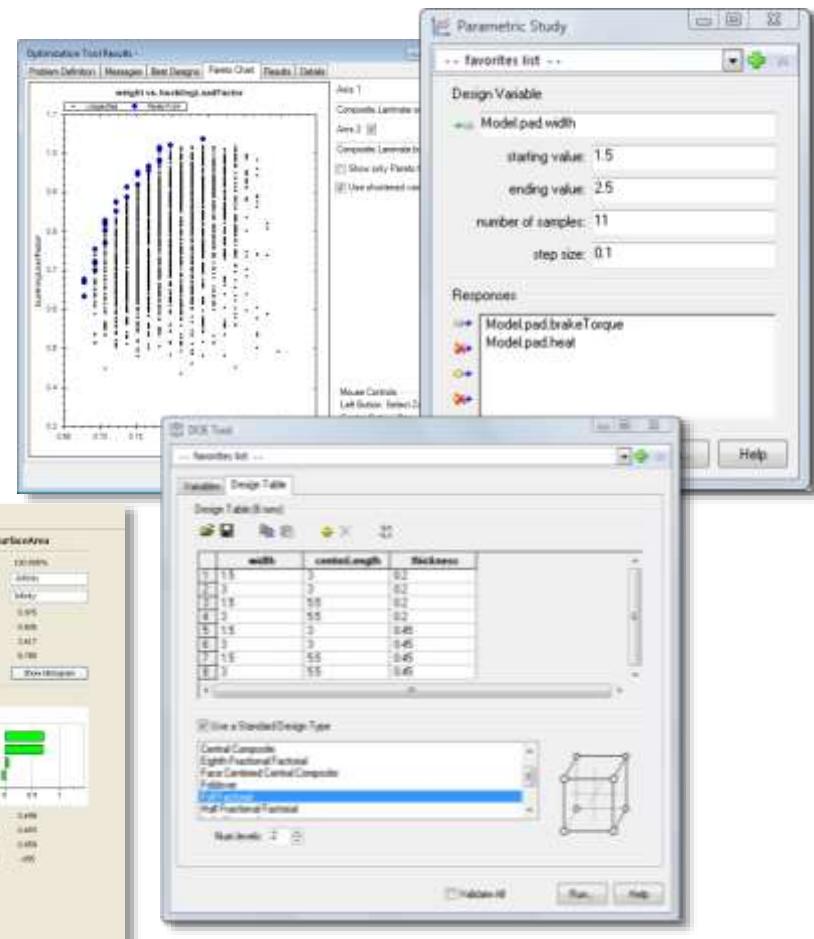
# Trade Study

- **Trade Study**

- 반복적으로 설계 대안을 탐색하고 최적 설계를 수행하는 연구 기법

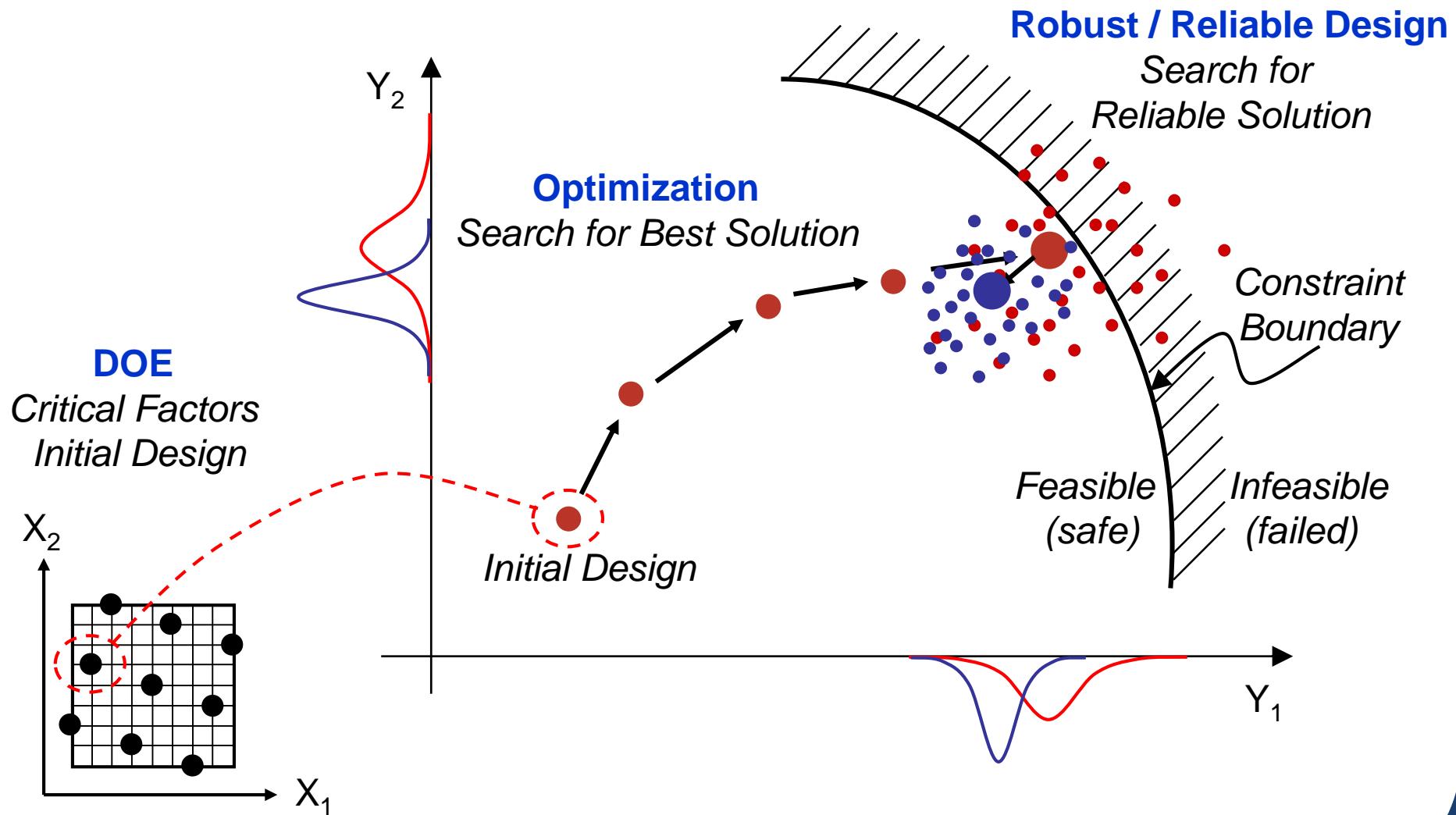
- **Trade Study 종류**

- Parametric Studies
  - Design of Experiments (DOE)
  - Sensitivity Analysis
  - Design Optimization
  - Probabilistic Analysis  
(Compute Reliability/Robustness)

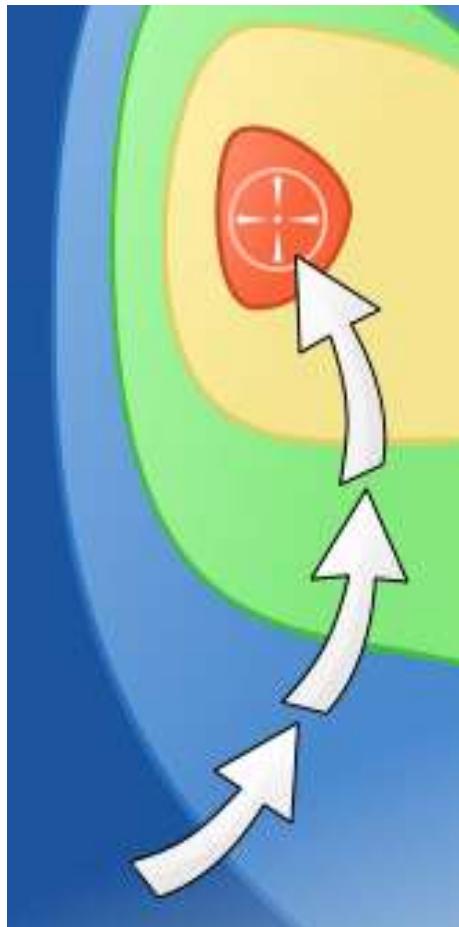


ModelCenter® Explore

# 설계 탐색 방법론 : Design Exploration Methodology



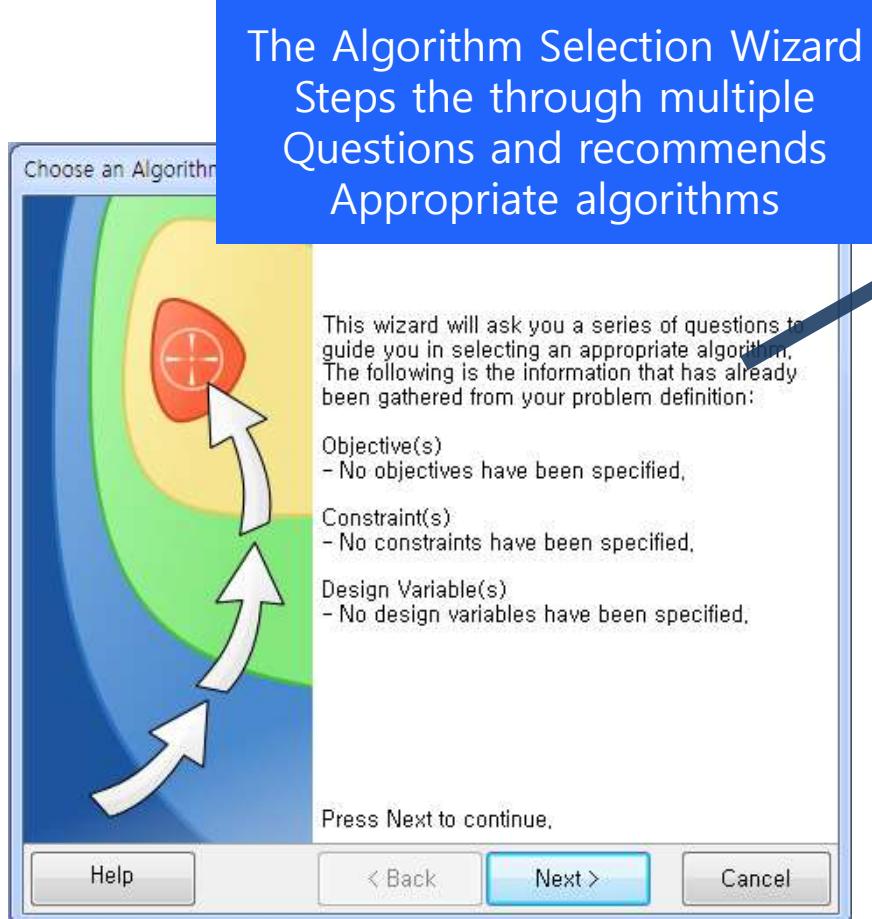
# Optimization



Feature	Details
<b>New Algorithms</b>	The optimization Pak has been expanded to include over 30 algorithms including the DAKOTA and SwarmOps toolkits
<b>Algorithm Selection Wizard</b>	Need help selecting the right algorithm? The optimization wizard steps you through the process and educates you at the same time
<b>Benchmark Profiles</b>	See how all of the algorithms perform against a number of benchmark test problems
<b>Unified Framework</b>	There is now a single GUI for all optimizers. Switching an algorithm is just a matter of selecting the item from the drop down list. Previous algorithms (DOT, DARWIN, Boeing Design Explorer) are all now part of the new framework.
<b>Simplified Software Development Kit</b>	Implement an interface in .NET or Java and we handle the rest. No GUI programming required

# Optimization Algorithms

The Algorithm Selection Wizard Steps the through multiple Questions and recommends Appropriate algorithms



This wizard will ask you a series of questions to guide you in selecting an appropriate algorithm. The following is the information that has already been gathered from your problem definition:

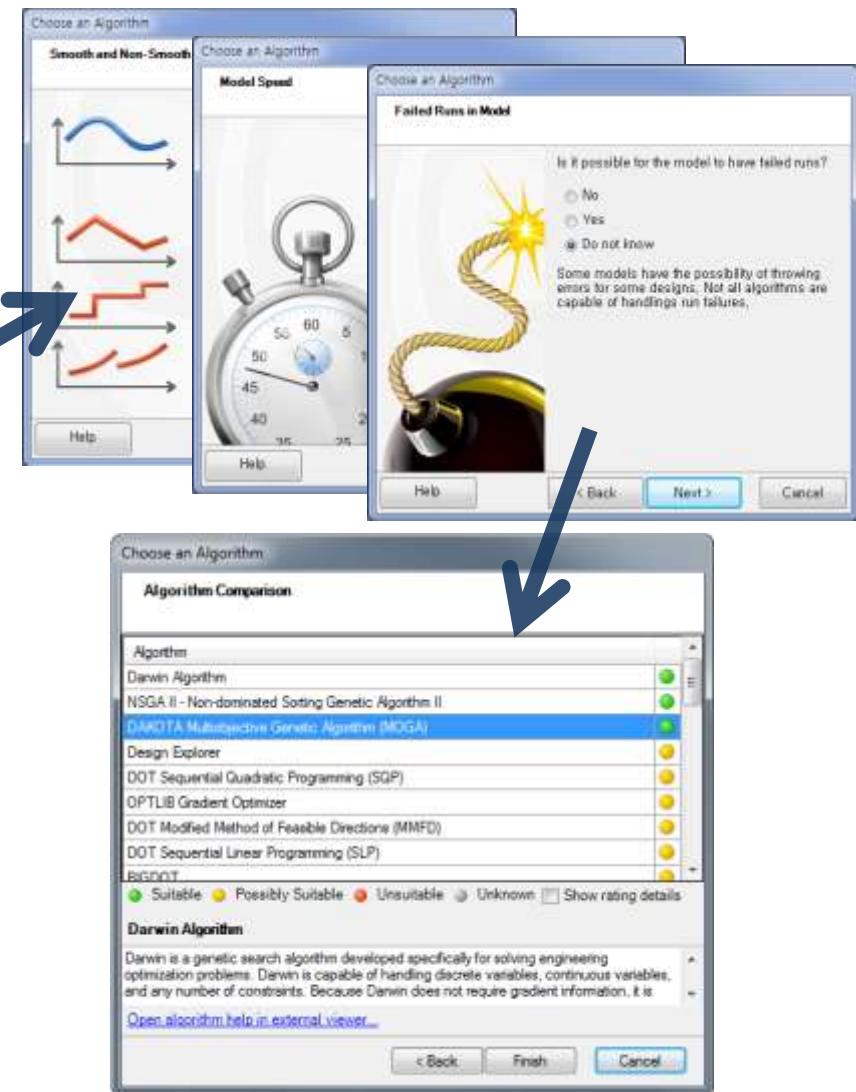
Objective(s)  
- No objectives have been specified.

Constraint(s)  
- No constraints have been specified.

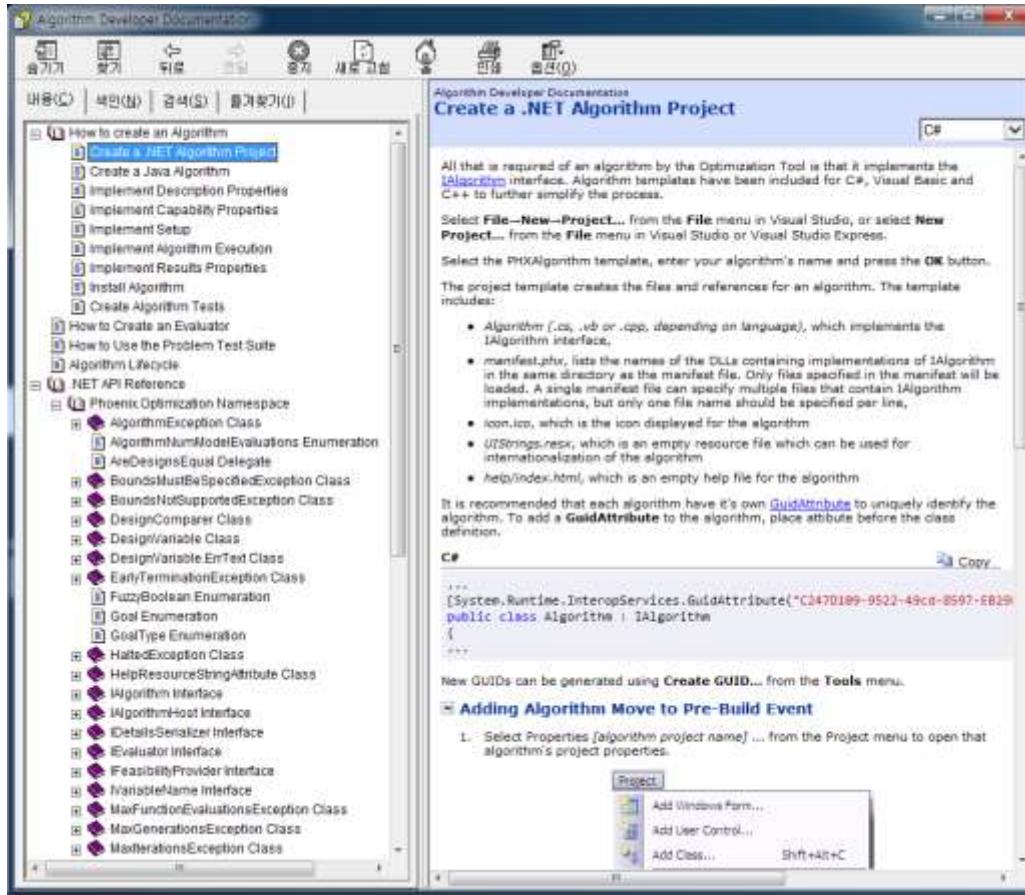
Design Variable(s)  
- No design variables have been specified.

Press Next to continue.

Help < Back Next > Cancel



# Add Your Own Algorithm



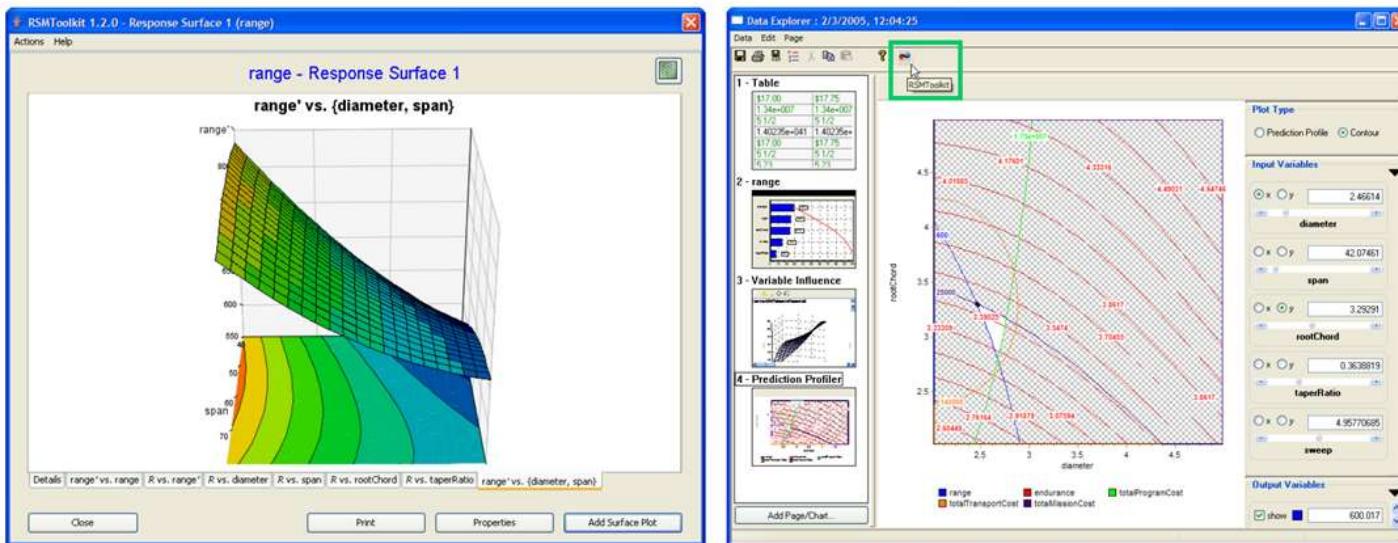
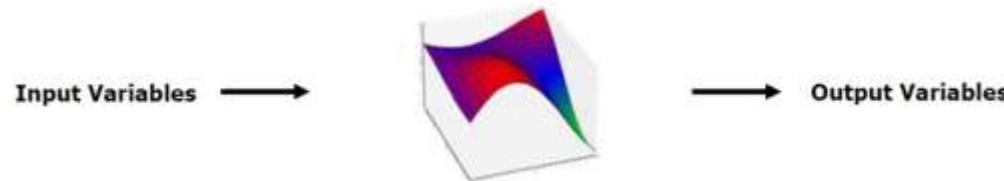
- **API documentation**
  - .NET and Java
- **Algorithm interface (IPHXAlgorithm)**
  - Algorithm metadata
  - Problem setup
  - Execution
  - Results
- **Callback interface used to:**
  - Requests function evaluations
  - Return status messages
  - Report best designs
- **Project Templates**
- **Unit tests suite for basic functionality**
- **Example source code**

# Approximation Model (근사 모델)

실제 해석 프로세스 (FEM)



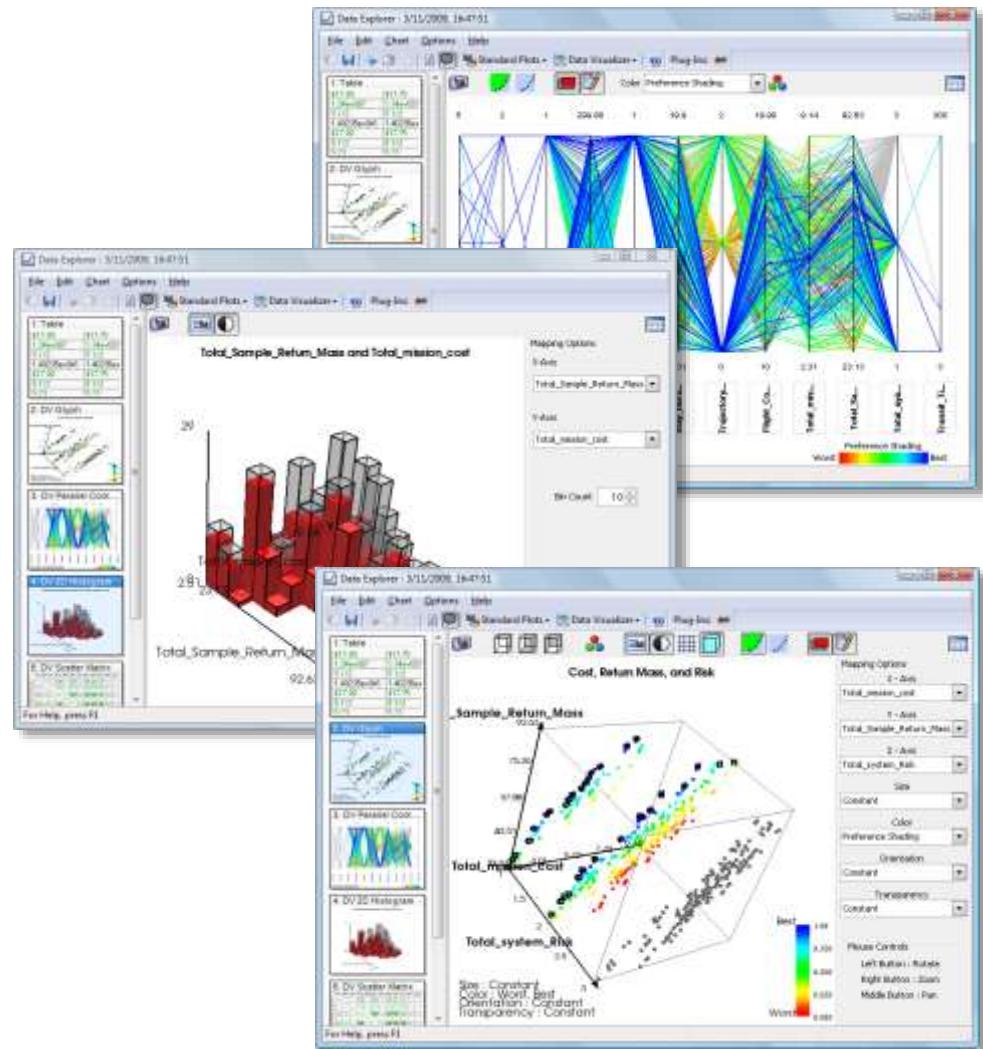
근사 모델 (RSM)



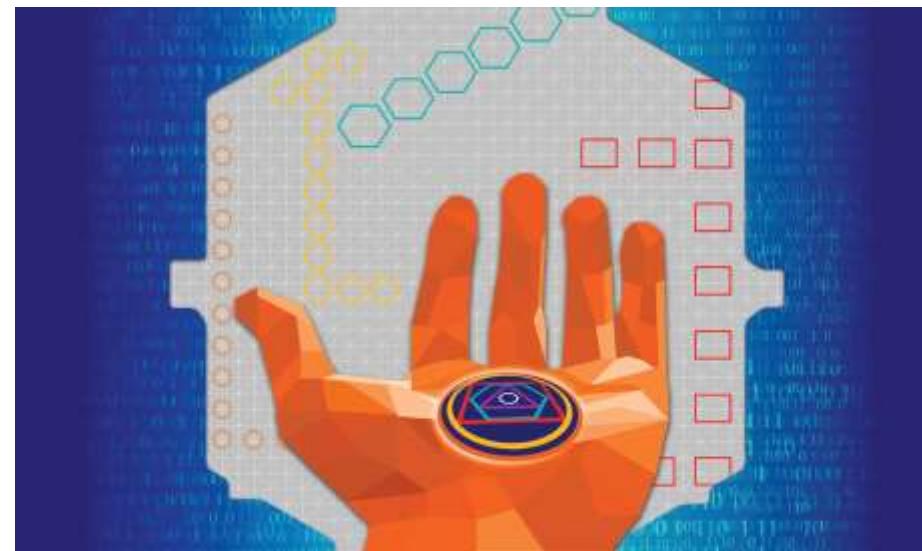
ModelCenter® Explore

# Visualize and Interpret Results

- Multi-dimensional glyph plots, parallel coordinates plots, scatter matrices, histograms, etc.
- Identify variable relationships
- Identify key variables
- Define goals and quickly visualize the resulting multi-dimensional Pareto fronts
- Interactive brush the data to understand the impact of constraints
- Graphical optimization



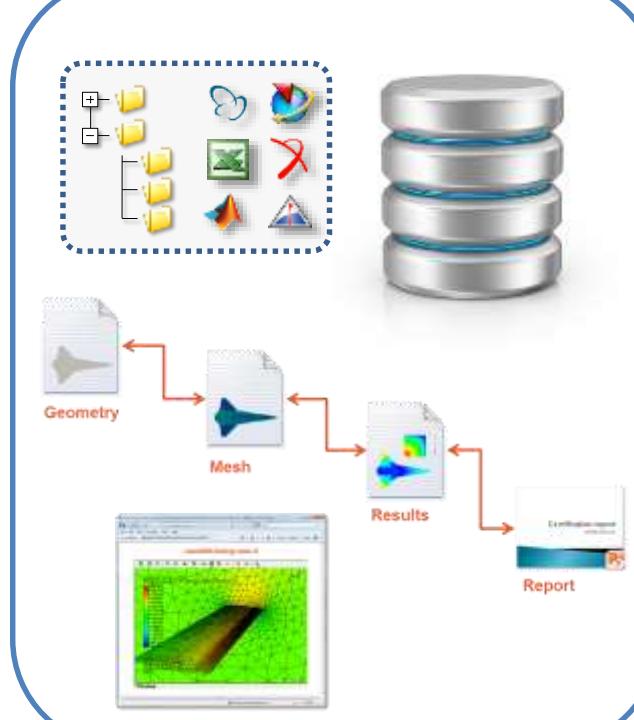
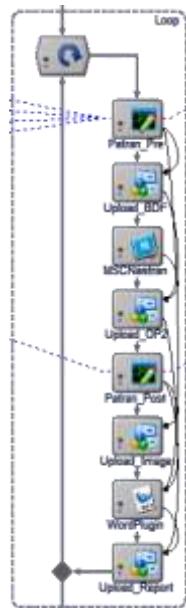
# ModelCenter® Organize



- **Archive data and meta-data used in and generated by Model Based Engineering applications**
- **Collaborate and share information with other team members and among stakeholders**
- **Establish and preserve the relationships between datasets to achieve traceability**
- **Re-use data and models**

# Simulation Data Management

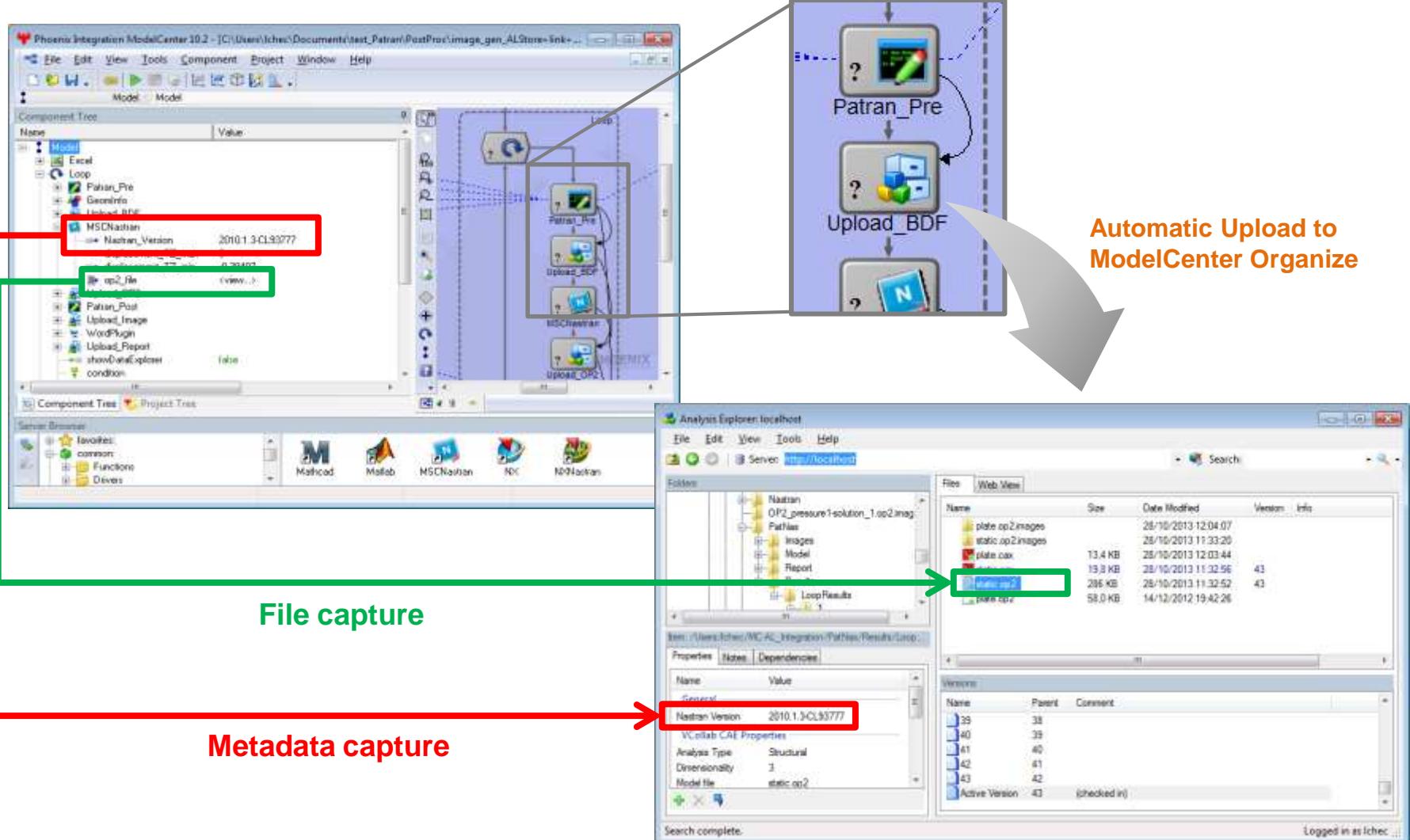
- Upload
- Download
- Search
- Automatic metadata capture
- Traceability



ModelCenter® Organize

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# Automated Workflow Data & Metadata Capture



# Shared Drive Plus

- **Automated Meta Data Extraction/Indexing**
- **Search**
- **Version Control**
- **Change Notification**
- **Web Access**
- **Custom Reports**
- **Customization (web views, clients)**
- **Integration with external data storage systems (PDM, SharePoint, etc.)**
- **Vendor Neutral**
- **Open API**

# Customizing Case



- Content Management, Collaboration and Automation Solution
- Improved efficiency after only 6-months

MODEL CENTER DISPLAY

FILE TOOLS HELP

WORKING DIRECTORY: /Users/Tests admin@http://localhost: connected

PSN13 Configuration

Inputs

Name	Type	Value
sGenericFile	file	<To Edit>
sRESDFile	file	<To Edit>
sFBDFile	file	<To Edit>
sResultFileName	string	
bConvertToExcel	boolean	true

Description Run-status LSF-status Result

The process extracts the PSN4 data and performs a part of the processing operations. It is used to apply the definition contained in a generic file to the defined analysis points and the provided calculation cases.

This generates a file called "executable sheet" (file with extension ".p13e") which will be readable by the commercially-available spreadsheets most commonly used in our field of activity.

A tabulated version of the "executable sheet" file can be created too.

Outputs

Name	Type	Value
sP13EFile	file	
sXLSFile	file	
sLogFile	file	

Generic File    RESD File (RESXXXX.RESD)    PSN13 RESULT File (RESXXXX.RSLVY)

Result File Name    Convert to XLS ?    PSN 13

Executable File (.p13e)    Tabulated File (.xls)

Run Scenario

Model: C:\Users\Phx\Documents\SDMA-AEROLIA\AS\_Wrappers\models\PSN13\Interface.pxc

# ModelCenter Cloud Deployment

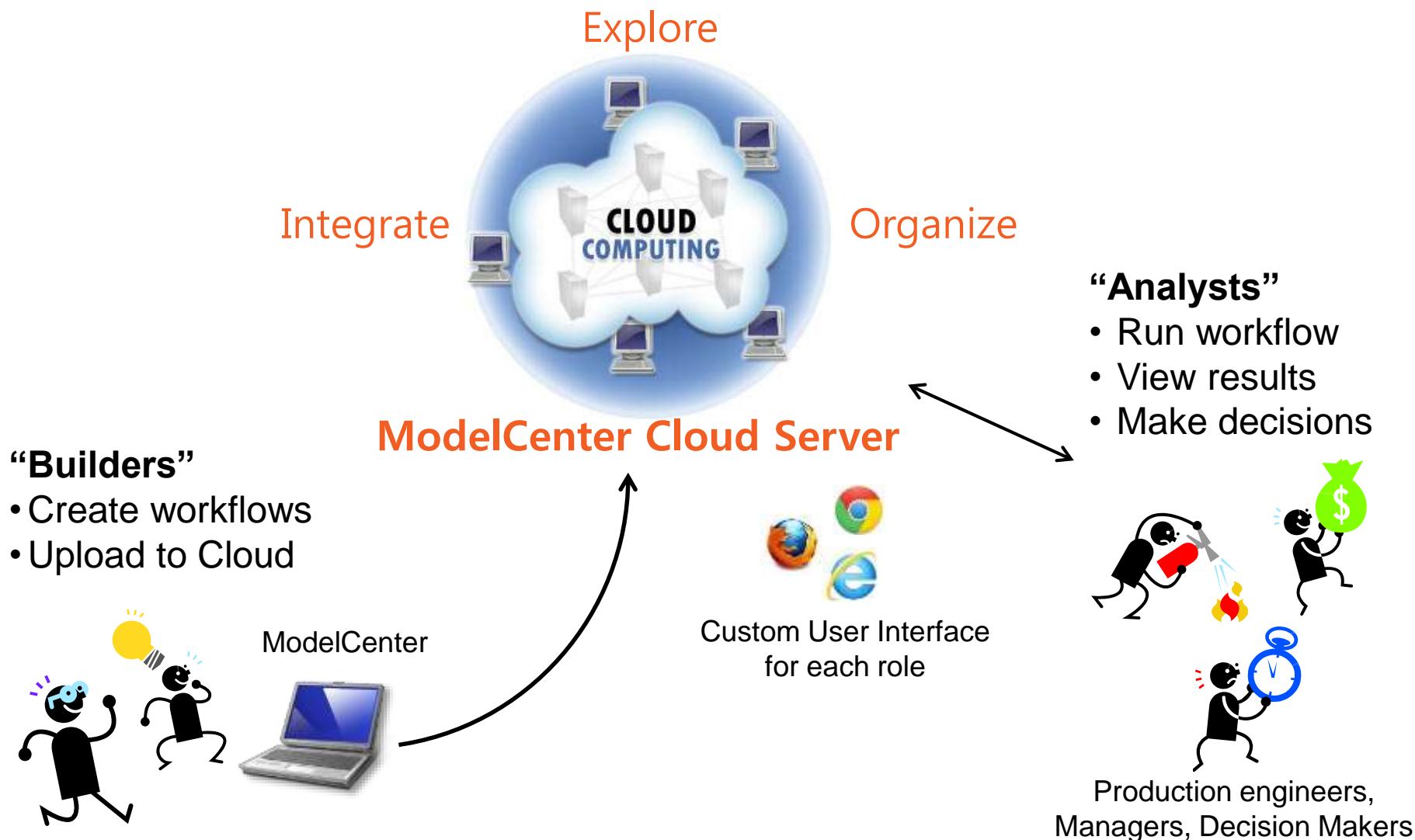
"I can see that this technology could provide a lot of value to our organization."

"However, all of my engineers are already very busy. They don't have time to learn new tools."

"How can you make this technology more accessible to my team?"

- Engineering Manager, US Automotive Manufacturer

# Cloud Deployment



# Default Web Interface

The screenshot shows the PHOENIX Integration software interface. On the left, there's a sidebar with navigation links like 'Department', 'Workingshop M...', 'My Model', 'Old workflow', 'Latest releases', 'Old workflow', 'Old workflow', 'Old workflow', and 'Old workflow'. The main area has tabs for 'WORKFLOWS', 'JOBS', and 'FILES'. A central dialog box is open, titled 'Initialize Job' with 'Job Name: v201'. It contains sections for 'Variables' (with a table showing 'model.a' with value 0.0, 'x' with value 0.0, 'param' with value 1.0, 'y' with value 3.3, 'c' with value 4.0, 'model.b' with 'input' and 'x' both at 1.0), 'Inputs' (with a table for 'model.input.x' to 'model.param.sl'), and 'Outputs' (with a table for 'model.input.y' to 'model.param.sl'). There are also 'Full Fractional' and '2' buttons, and a 'Ref Level' dropdown.

The screenshot shows the 'JOBS' tab of the PHOENIX Integration software. At the top, there's a search bar with 'Filter jobs based on job names...'. Below it is a table with columns: 'Job Name', 'Status', 'Progress', and 'Actions'. The table lists several jobs:

Job Name	Status	Progress	Actions
My model	Pending	0% Pending	[Pause] [Stop] [Edit]
Model 001 - Paused	Paused	Paused 0%	[Resume] [Stop] [Edit]
Model 002 - Completed	Completed	100% completed	[Edit]
Model 103 - Cancelled	Cancelled	-	[Edit]
Model 104 - Completed	Completed	100% completed	[Edit]
Model 008 - Completed	Completed	100% completed	[Edit]

At the bottom, there are links for 'PHOENIX', '©2015 Phoenix Integration | Privacy | Contact Us', and 'www.lotustech.co.kr'.

## Workflow Execution

# Default Web Interface

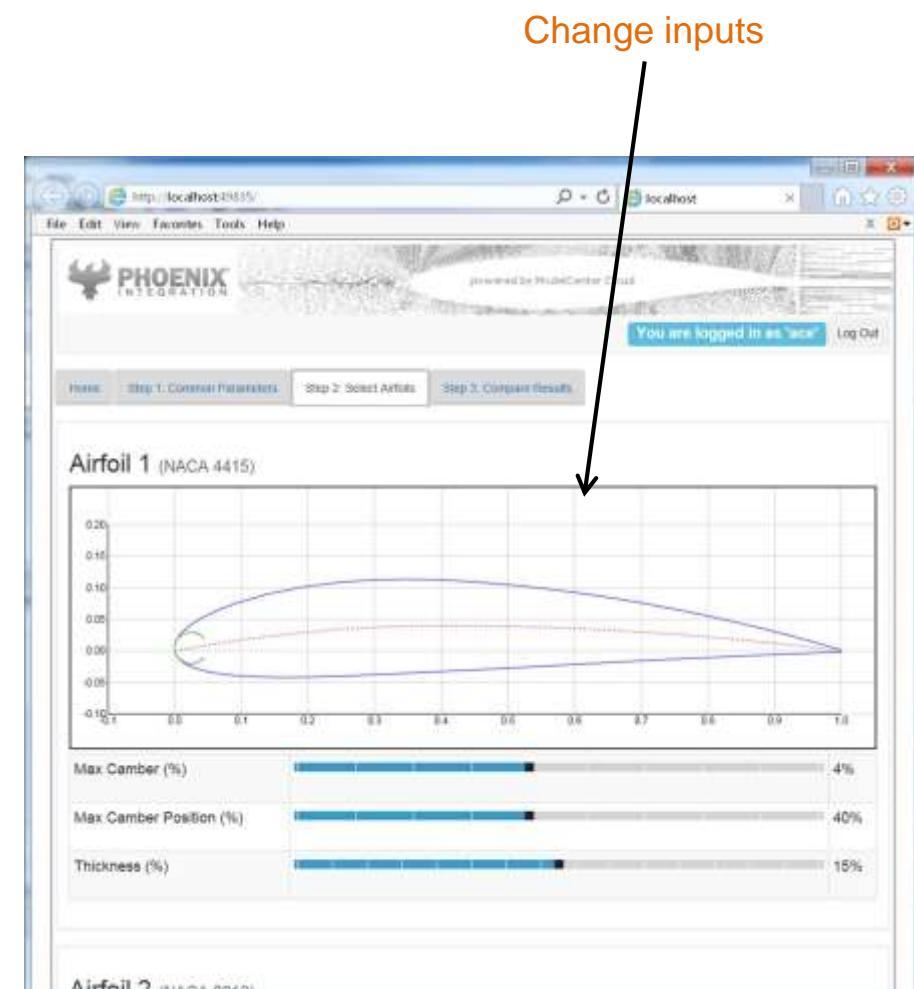
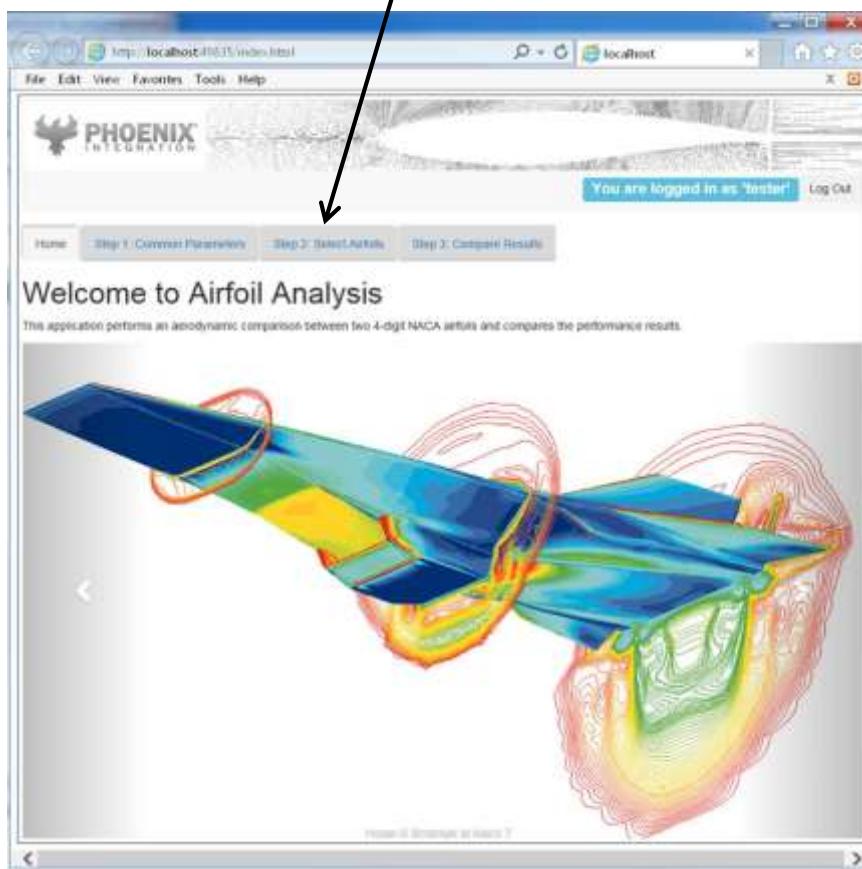
The screenshot shows a web-based interface for managing simulation files. On the left, there's a sidebar with a tree view of project components like 'Structure', 'Aerodynamics', and 'Flows'. The main area has tabs for 'WORKFLOW', 'JOBS', 'FILES', and 'LOGOUT'. A 'Details' dialog box is open over the 'FILES' tab, showing information for a file named 'block-hole\_sim1\_solution\_1.op2'. The dialog includes a 'Properties' table with columns 'Name' and 'Content', listing various parameters such as Model File, Analysis Type, Dimensions, Number of Elements, Number of Nodes, Solution Date, and Solution Time. There are also links to 'View containing folder' and 'Downloading this file'.

## Data Management

This screenshot shows a 'Drag File(s) to Upload or click to select' dialog box overlaid on the PHOENIX interface. The dialog has 'Cancel' and 'Upload File' buttons at the bottom. The background shows the same navigation and sidebar as the previous screenshot, indicating the dialog is part of the same application.

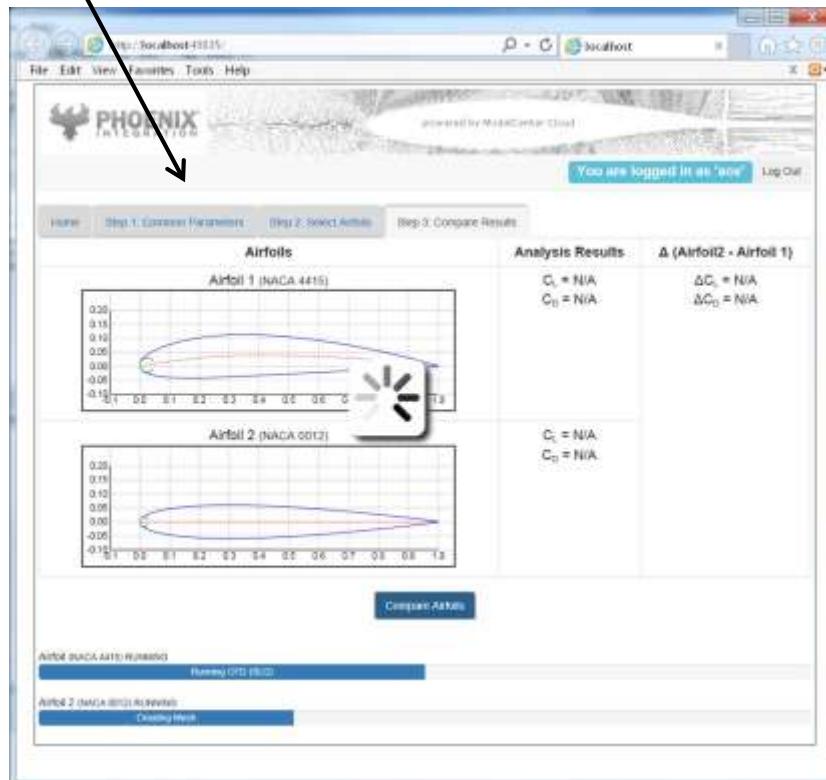
# Example User Interface

Guide users through a sequential process

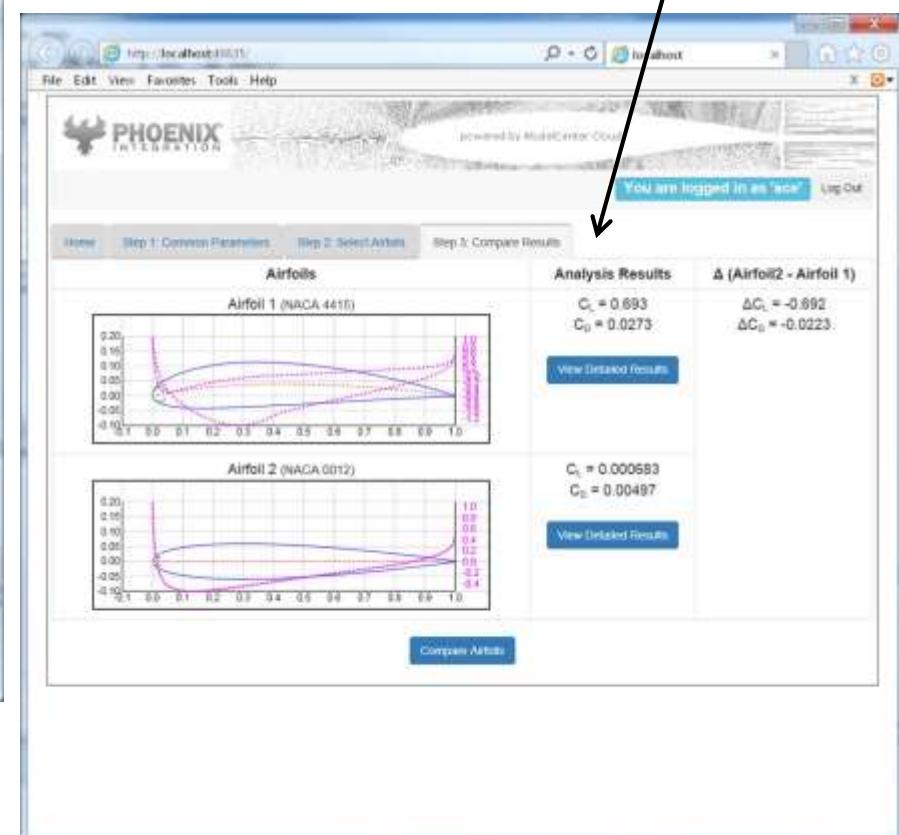


# Example User Interface

Run

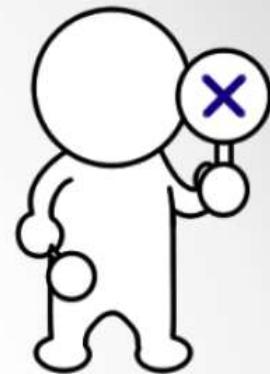


View outputs



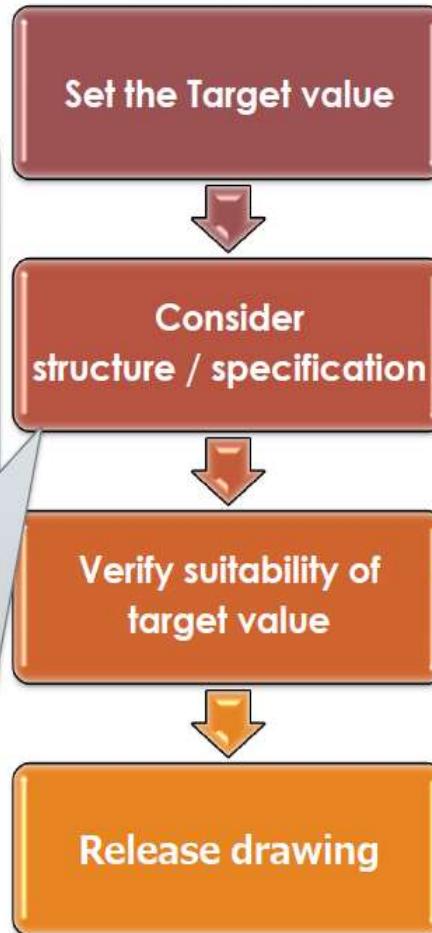
## 3. Current problems

### Design with waste and rework



(Example: Design Process for parts)

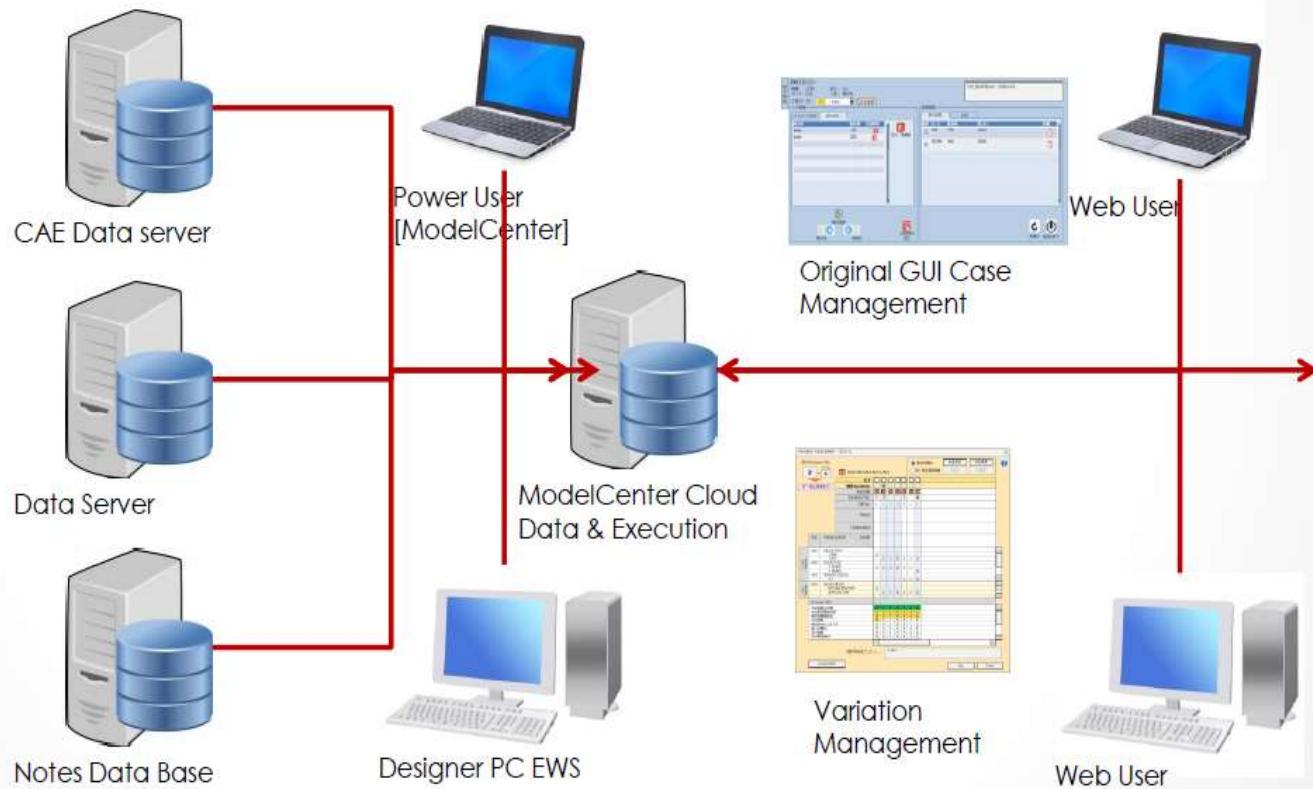
- Rework caused by omission of examination item
- Time wasted on information retrieval



- Manual input is too time-consuming
- Rework caused by mistaken inputs



# System Image



# 8.Why we chose MCC

\*MCC=Model Center Cloud

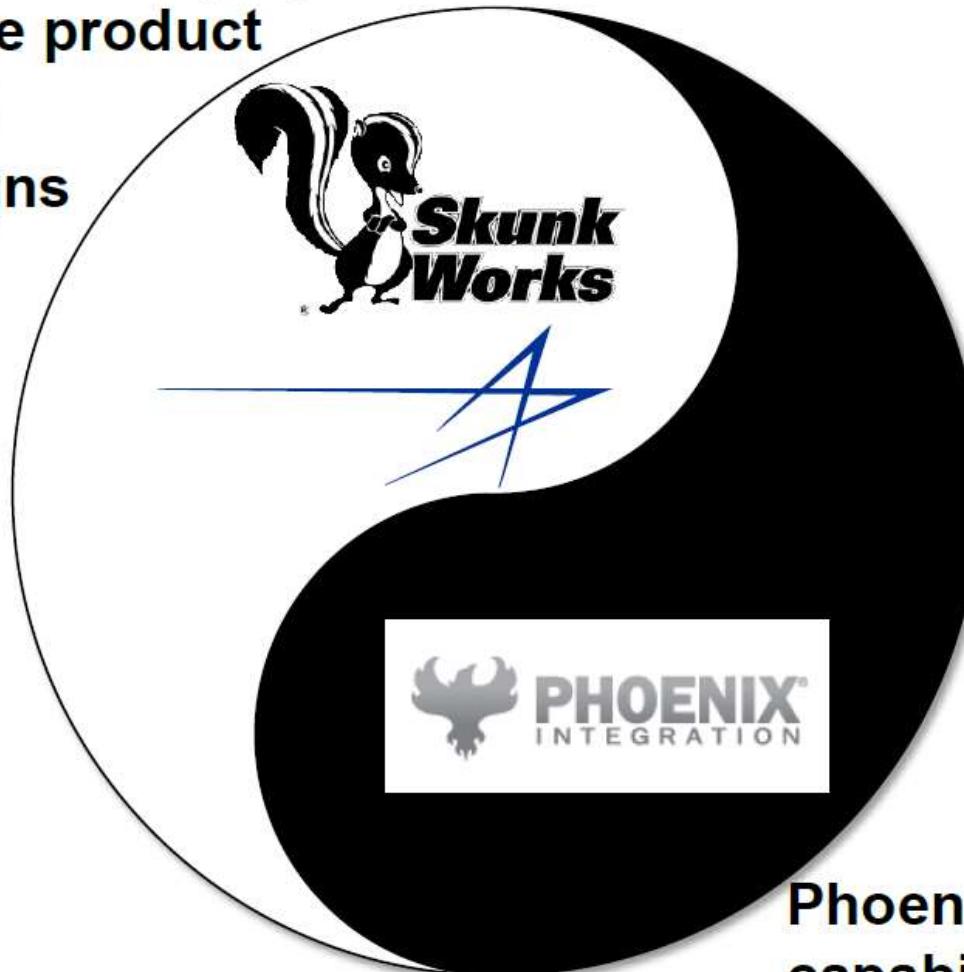
- Firstly, we research and try Proof Of Concept for some tools.
- Reasons for selecting PHX
  - Openness
    - API preparation
    - User can make Plug-In, etc...
  - Flexibility
    - Easy to control process
  - Web architecture based system using modern technologies

# Case Examples



# Early, Driven Partnership

- Problems we were trying to solve drove product development
- Unique Designs



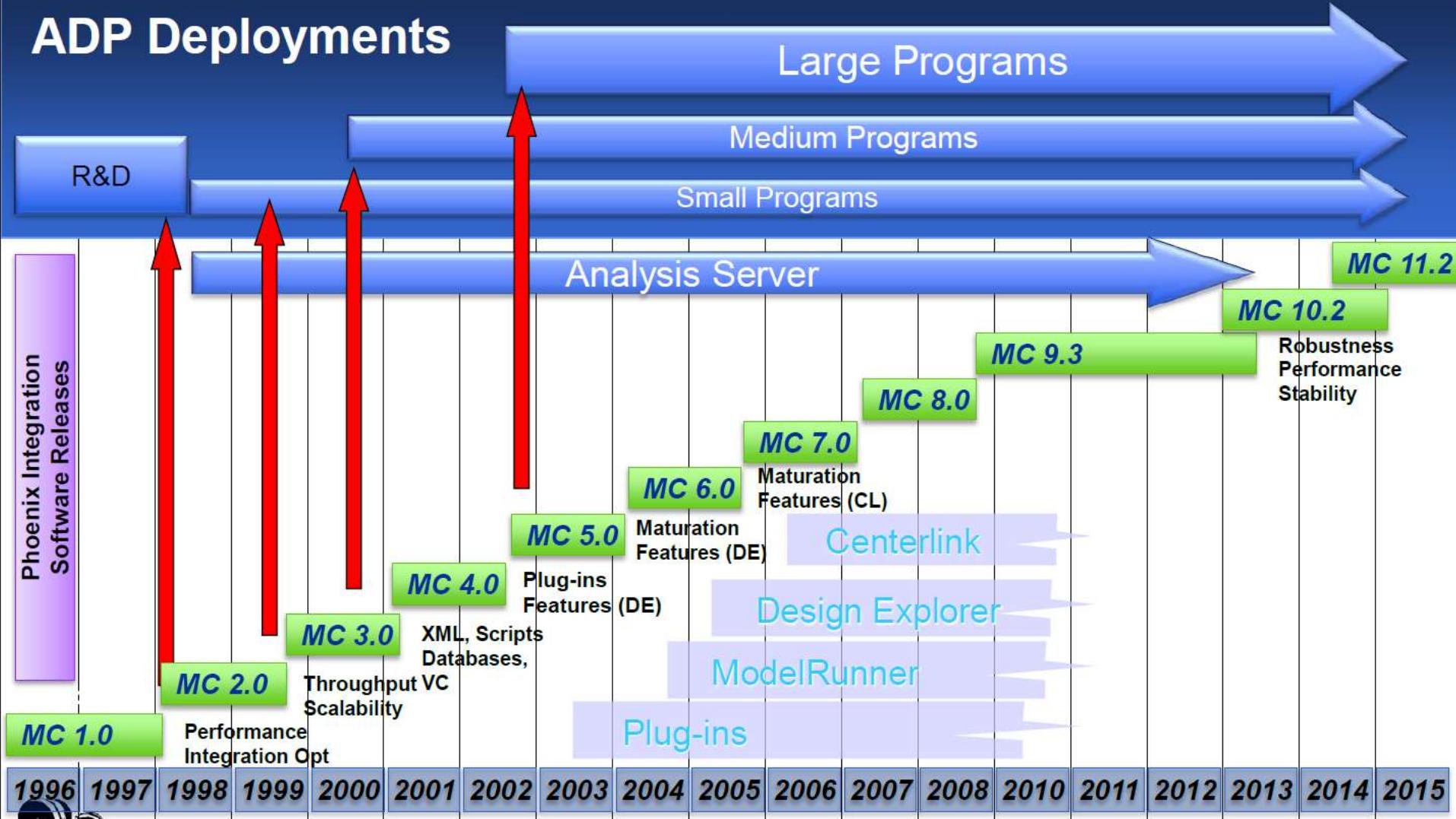
**Phoenix Int. product capabilities enabled our unique solutions**



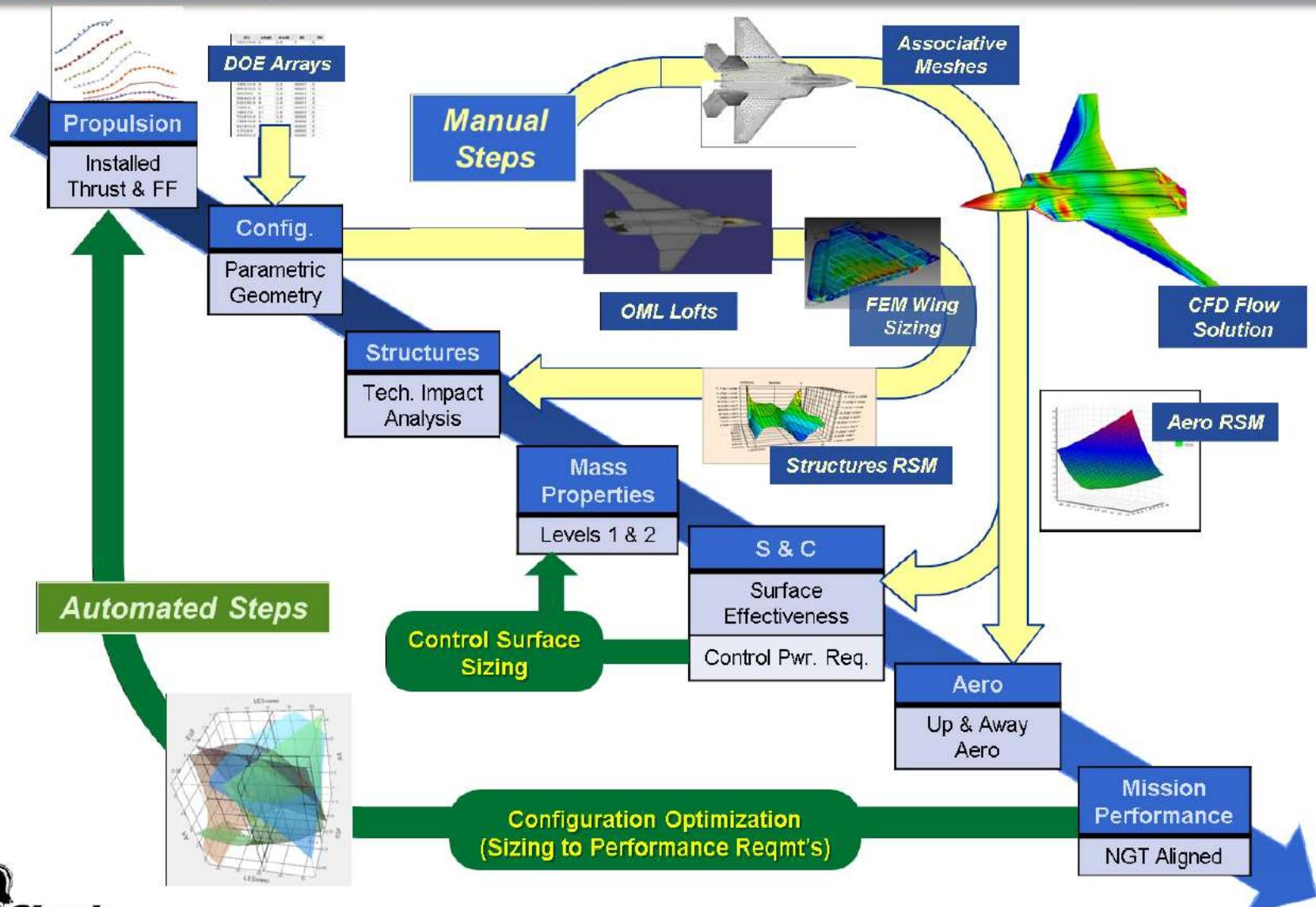
# RCD Program Deployments



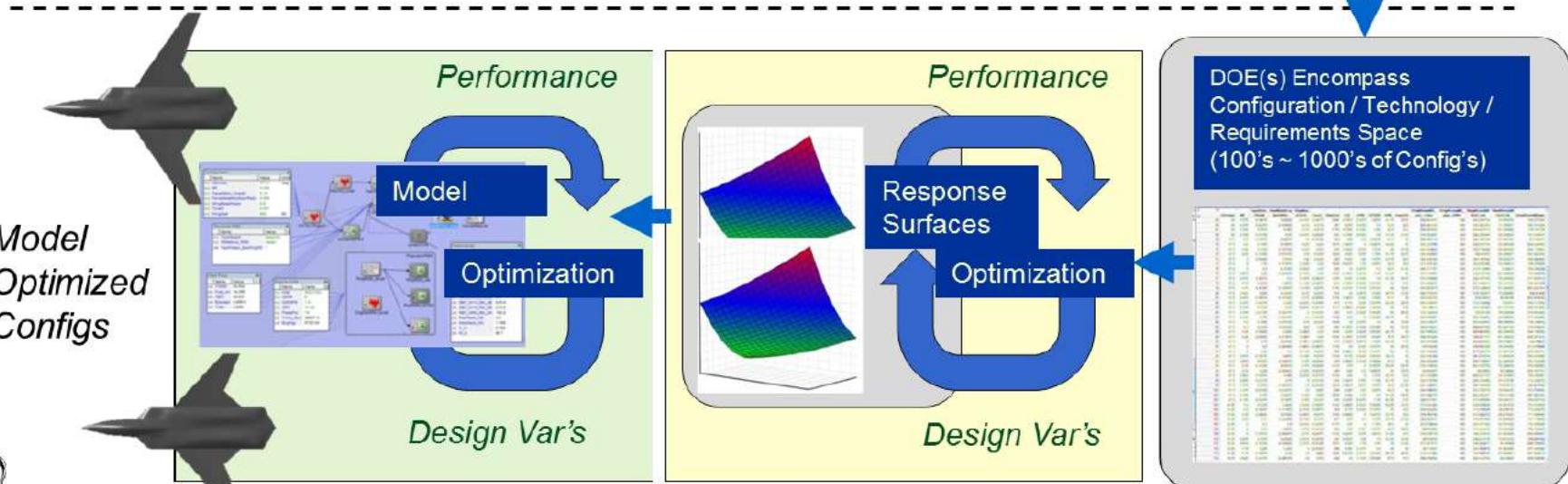
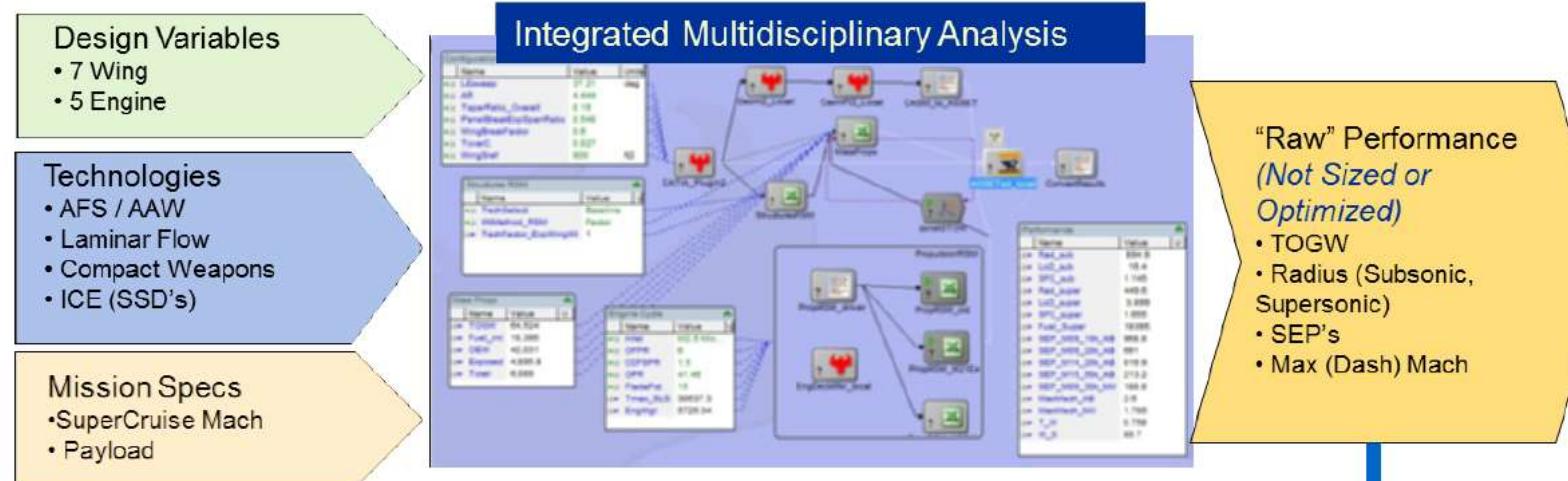
## ADP Deployments



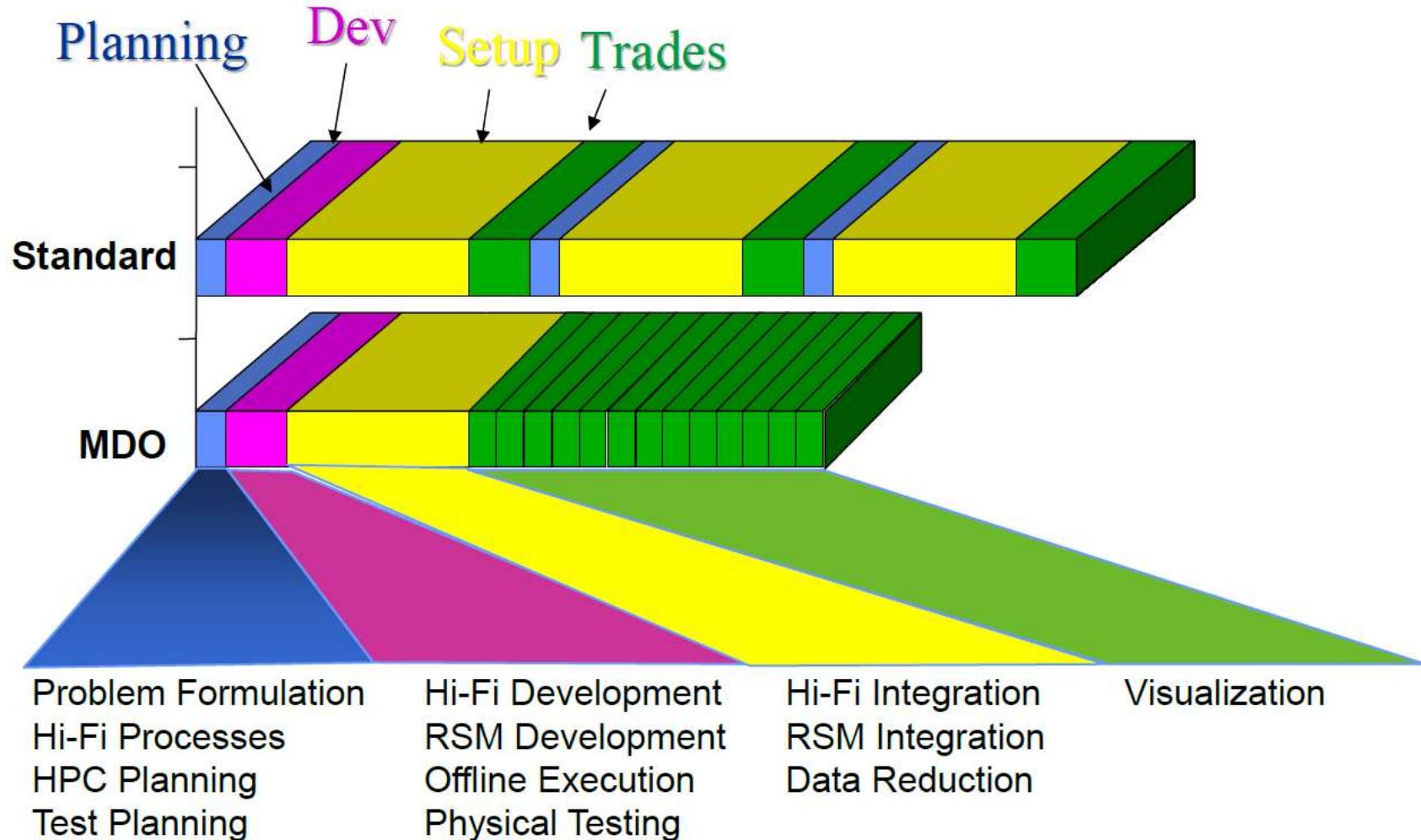
# Modelcenter Process Changes – ESAVE Program



# ESAVE MDO Approach: RSM-Based Optimization



# Changing MDAO Process



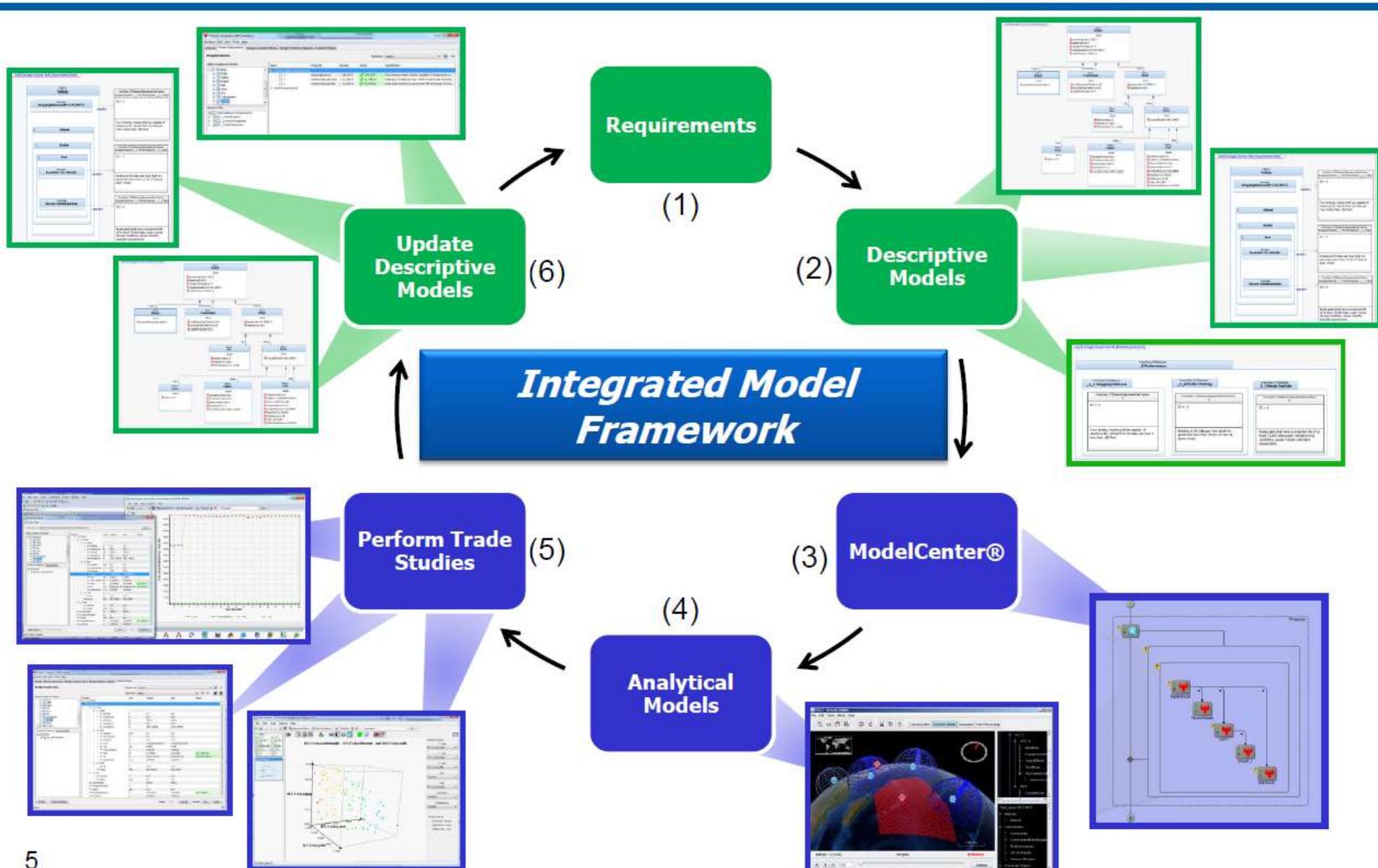
# Where is ADP Going With Phoenix/MDAO



- **Model Discipline Growth**
  - Increased model complexity
  - Increased DV's, constraints and objective functions
  - RSM methodology
- **High Performance Computing**
  - Higher fidelity earlier in programs
  - New Physics
  - Increased discipline coverage
- **Pervasive MDOA**
  - Web based MDAO
  - Server/Cluster based computing
  - Service/Agent based computing

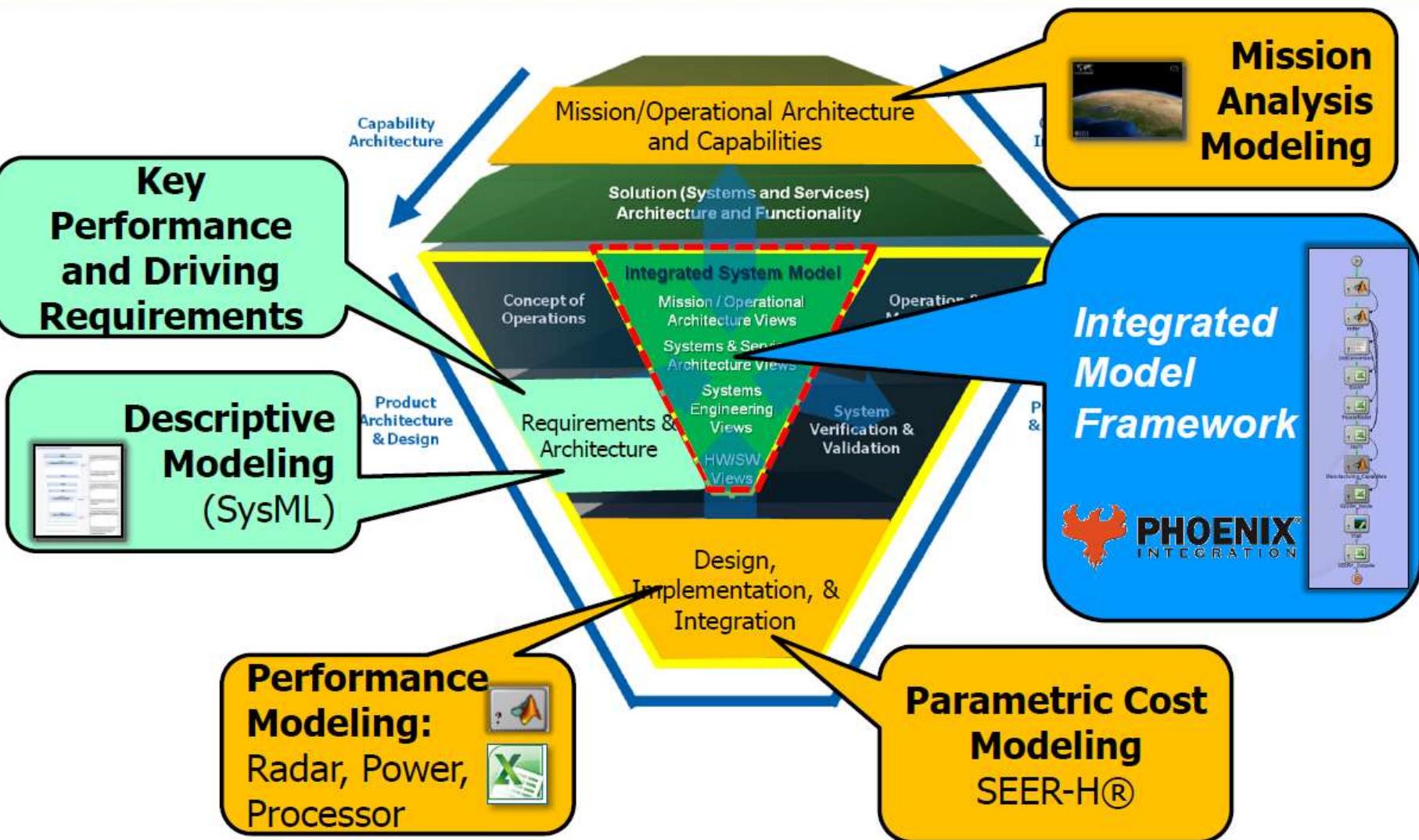
# Integrated Model Framework: Descriptive to Analytical and Back

NORTHROP GRUMMAN



# Utilizing Disparately Designed Models to Perform Trade Analysis

NORTHROP GRUMMAN

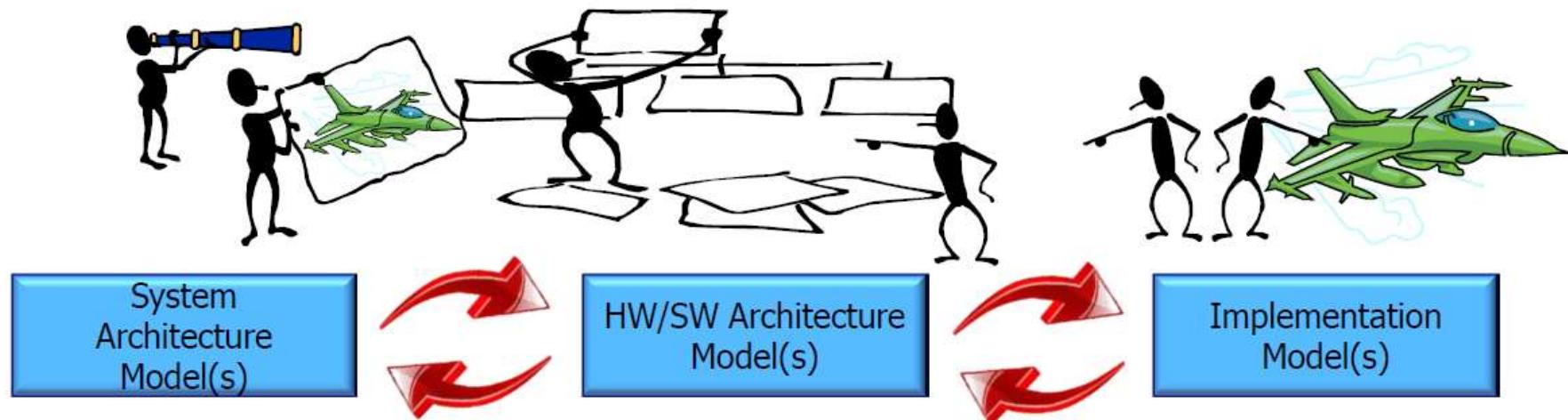


System level models from different departments inherently share information

# Model Based Engineering – Electronic Systems

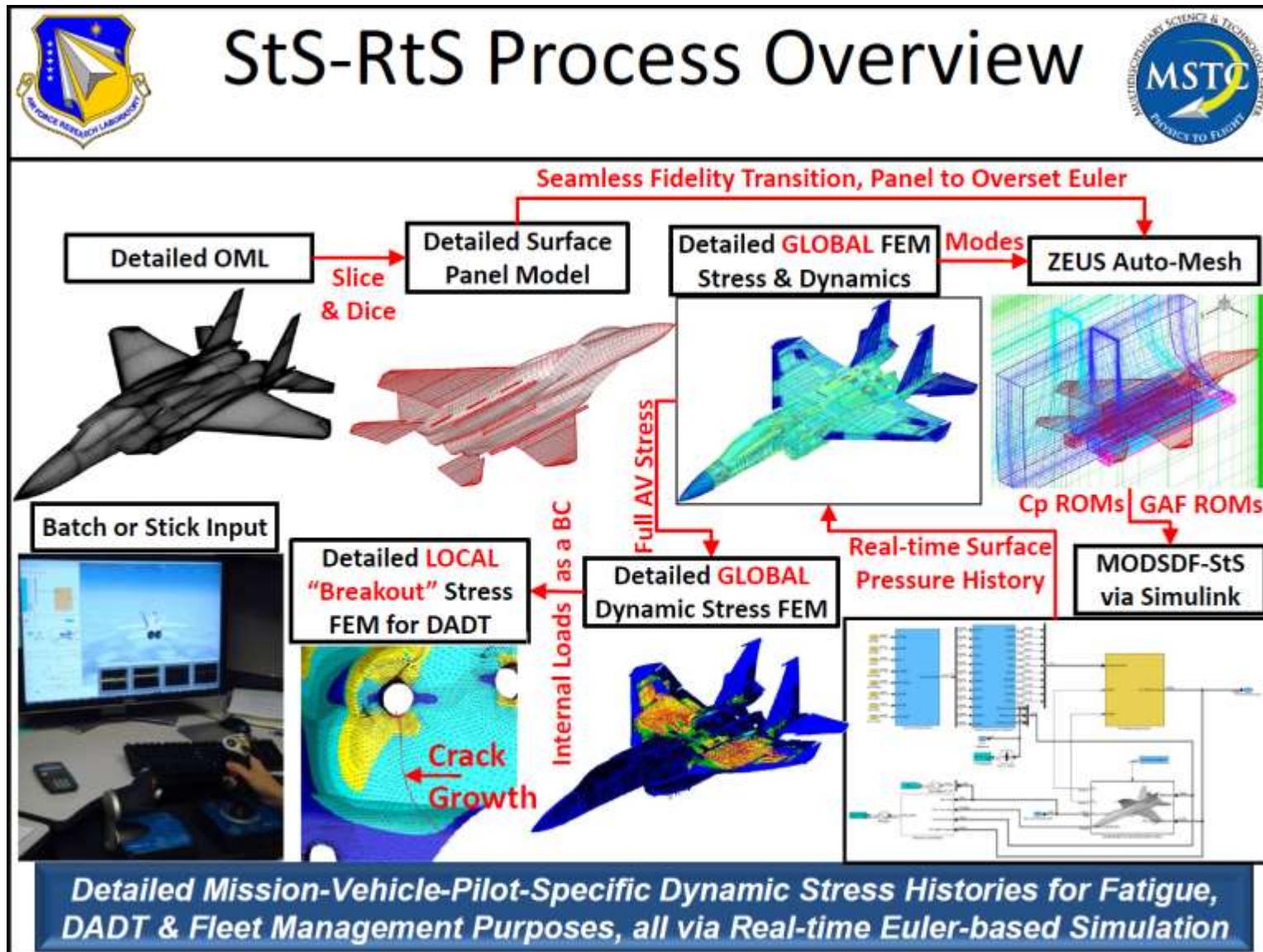
NORTHROP GRUMMAN

**MBE** is an approach to engineering that uses models as an integral part of the technical baseline that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle. (NDIA)

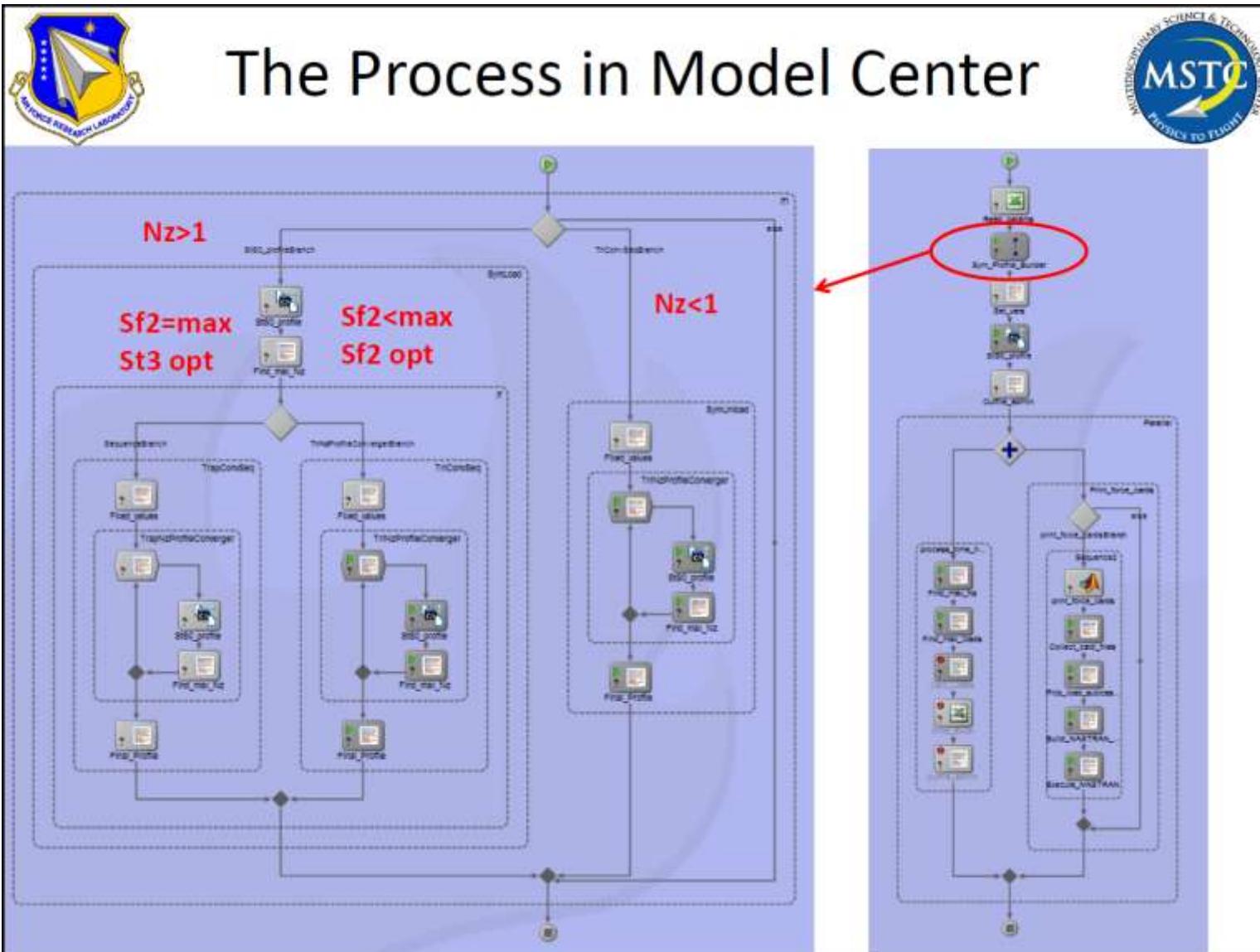


- Proven results at NGES with MBE with demonstrated
  - Reduction in cost
  - Reduction in schedule
  - Improvement in delivered quality
  - Higher customer engagement in the engineering process and satisfaction with the results

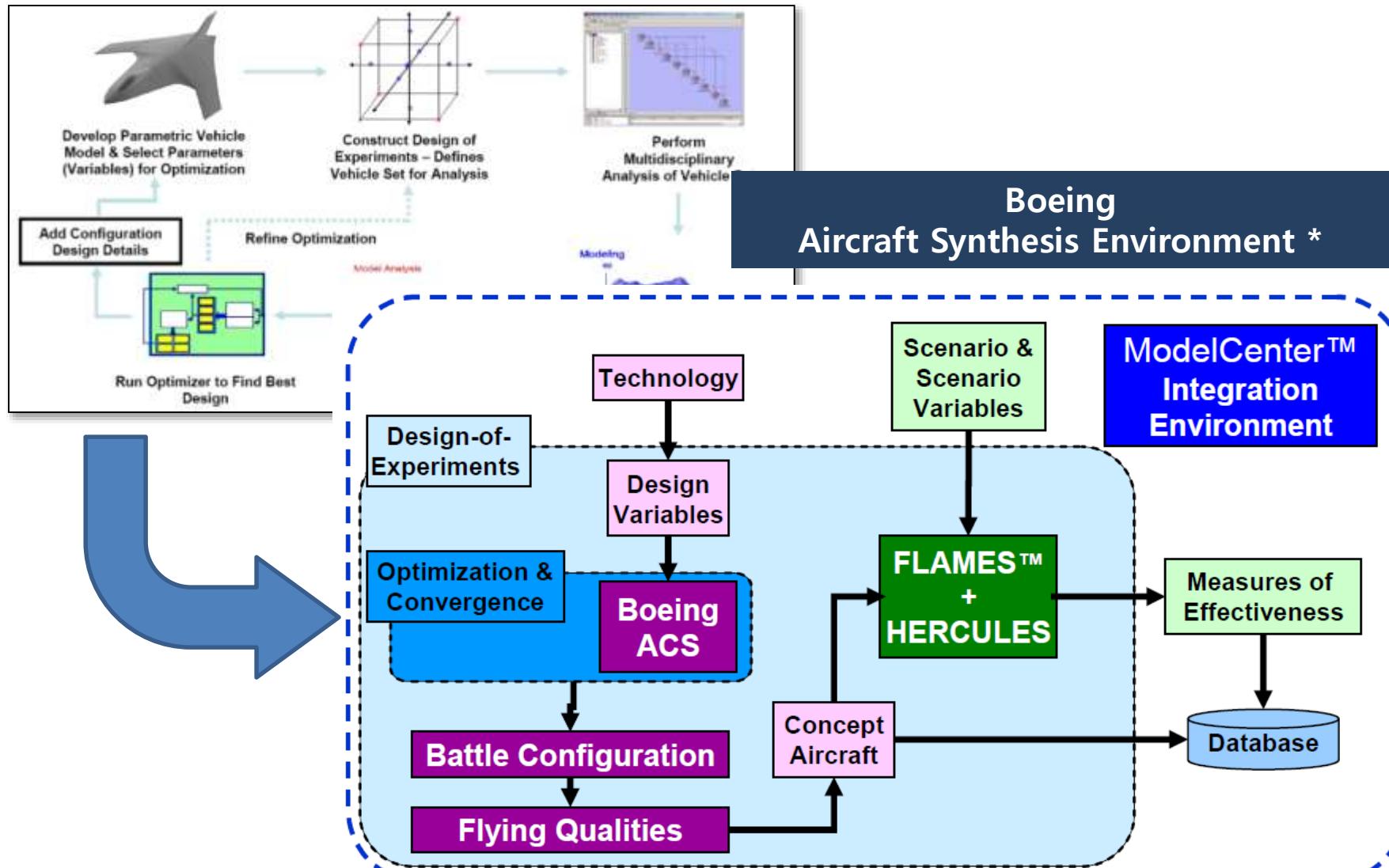
# Symmetric Maneuver Loads Module Development & Integration within an Aircraft Tracking Environment



# Symmetric Maneuver Loads Module Development & Integration within an Aircraft Tracking Environment



# Boeing



\* AIAA 2008-1443 "Integrating Synthesis and Simulation for Conceptual Design"

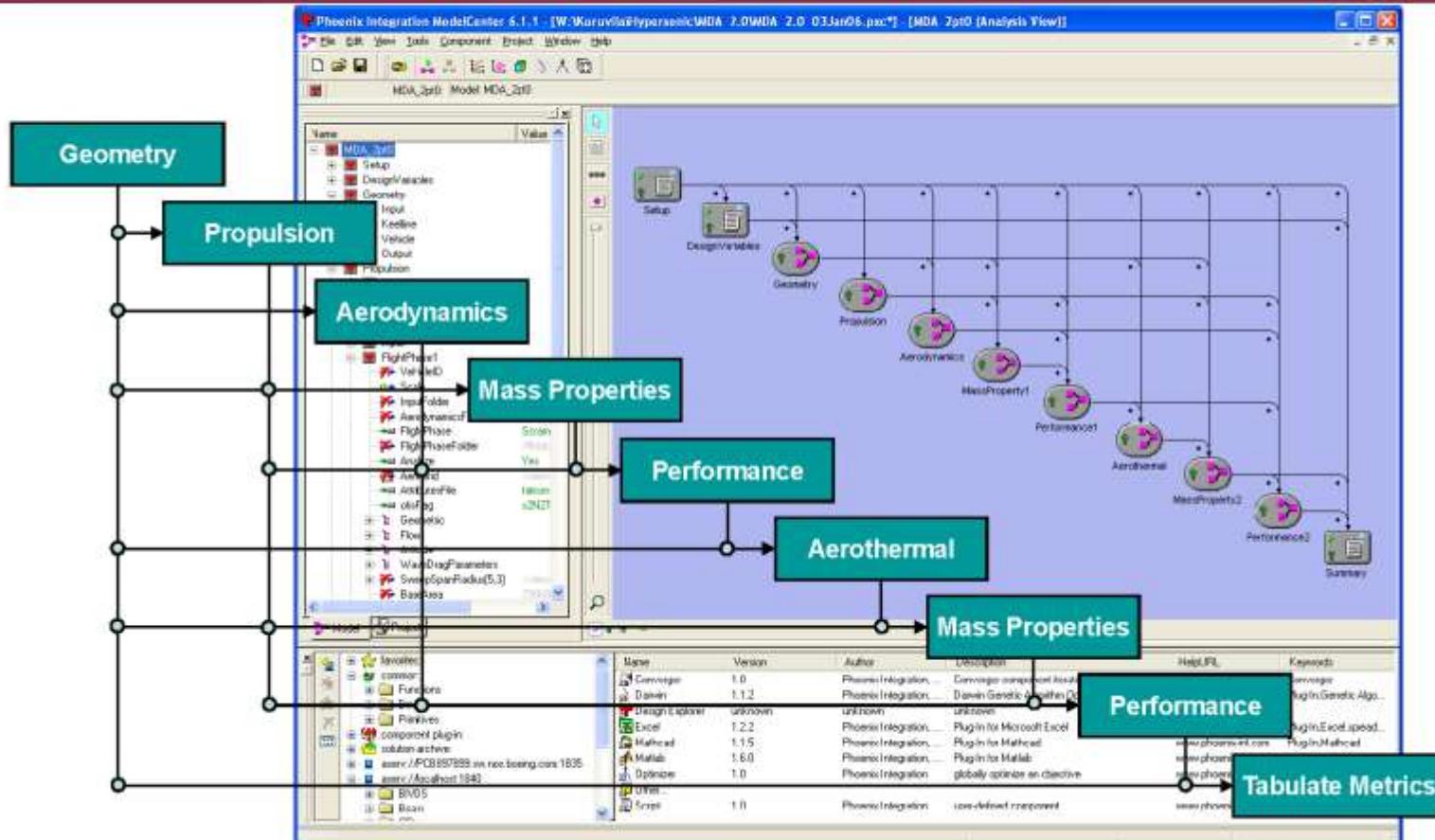
Boeing



# ModelCenter® Used to Integrate Hypersonic Vehicle Analysis Tools Into an MDA System

Boeing Technology | Phantom Works

Hypersonic Design and Applications



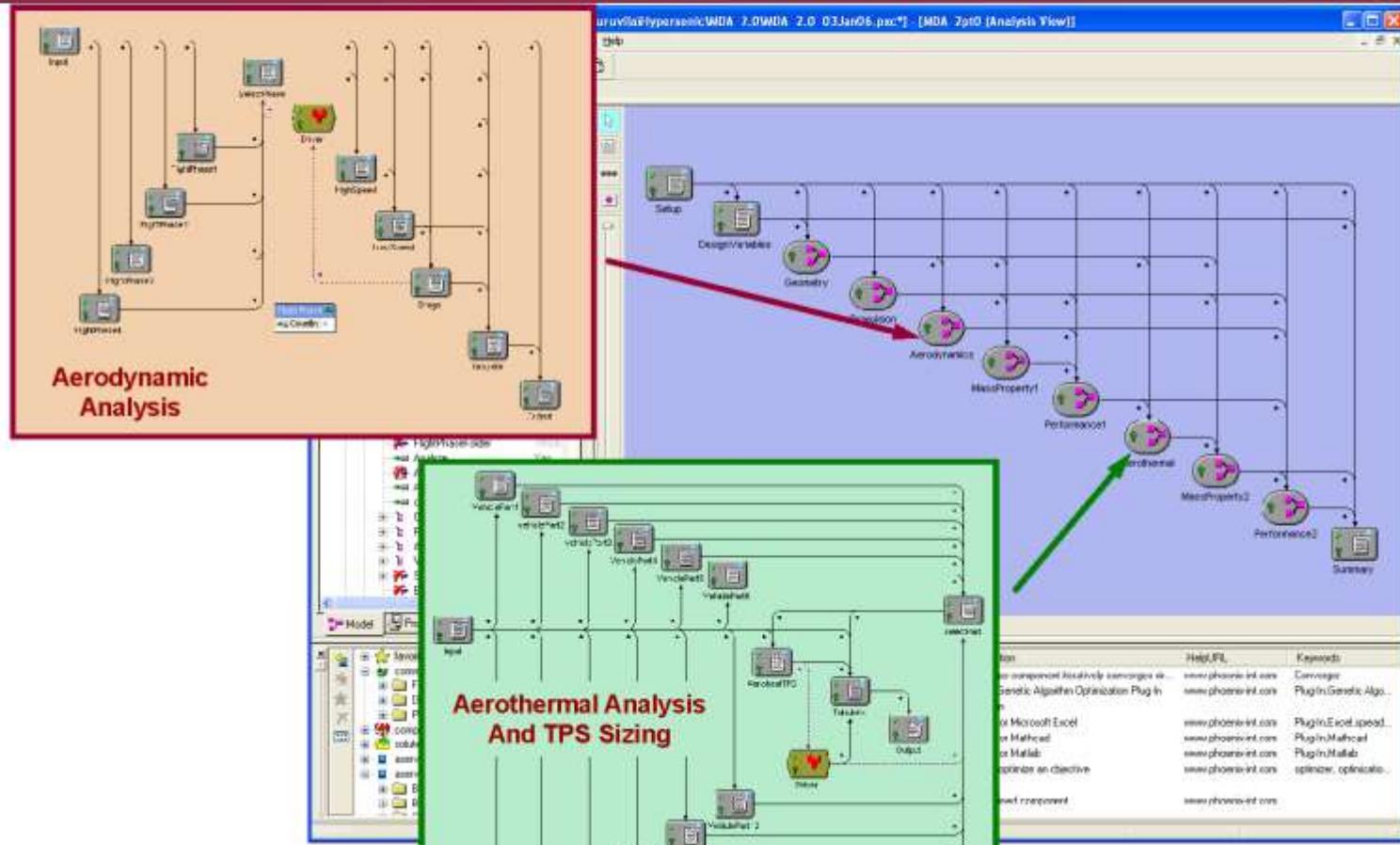
Boeing



# ModelCenter® Used to Integrate Hypersonic Vehicle Analysis Tools Into an MDA System

Boeing Technology | Phantom Works

Hypersonic Design and Applications

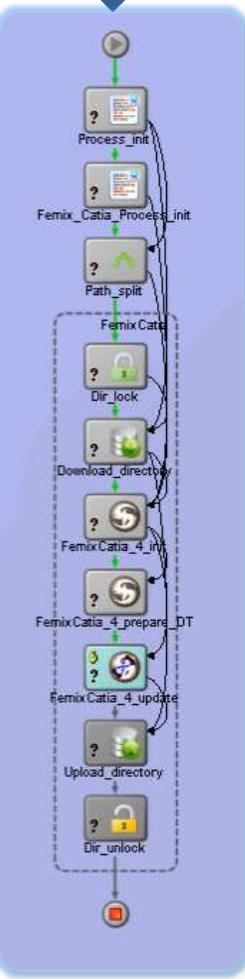
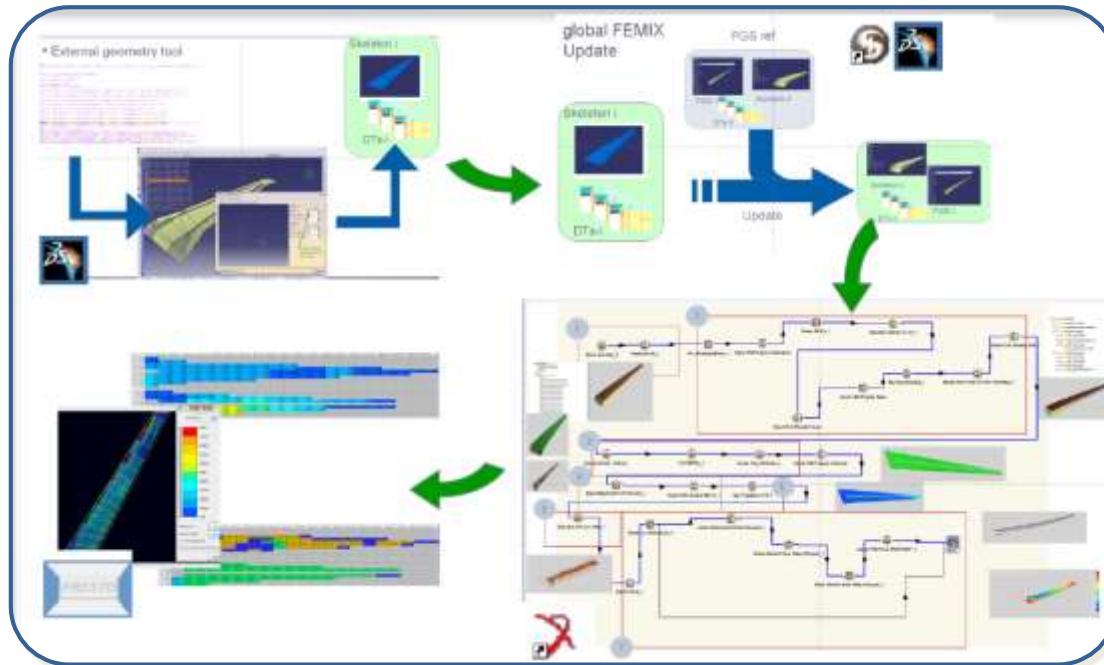


# Airbus



- **COTS/In-house SOFTWARE INTEGRATION**
  - Use Case 1 : CATIA, SimXpert, NASTRAN drivers direct use
  - Use Case 2 : Wrapper Update PGS with « ecascade » from current PC.
  - Use Case 3 : Wrapper for Nastran in GISEH(Linux)
  - Use Case 4 : Wrapper PRESTO batch run in GISEH(Linux)
- **DATA MANAGEMENT/ NETWORK**
  - Use Case 5 : Update PGS with « ecascade » with laptop and Run PC
  - Use Case 6 : Data management for ESA data in MDAACE
  - Use Case 7 : Laptop for MC+ 2PCs (one for CATIA run, one for SimX run)
  - Use Case 8 : Integration of data management wrappers with a SimX template
- **REAL CASES**
  - Use Case 9 : Integration of data management wrappers in Update PGS process in current PC / integration of data management wrappers on FEM generation template in SimX
  - Use Case 10: MDAACE posttreatment process for EI/GJ
  - Real Use Case scale 1 : Complete FEMIX process integration in parallel (several run PCS for same application- dynamic selection)

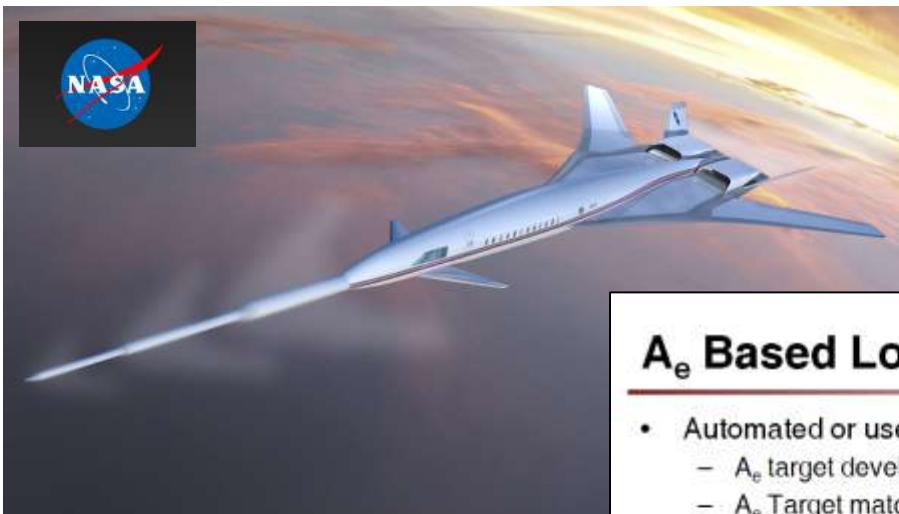
# Airbus



## • Results :

- Time saving : 20min compared to half day
- Reduction by 10! a lot of manual operations
- Complete traceability
- No human mistake

# NASA

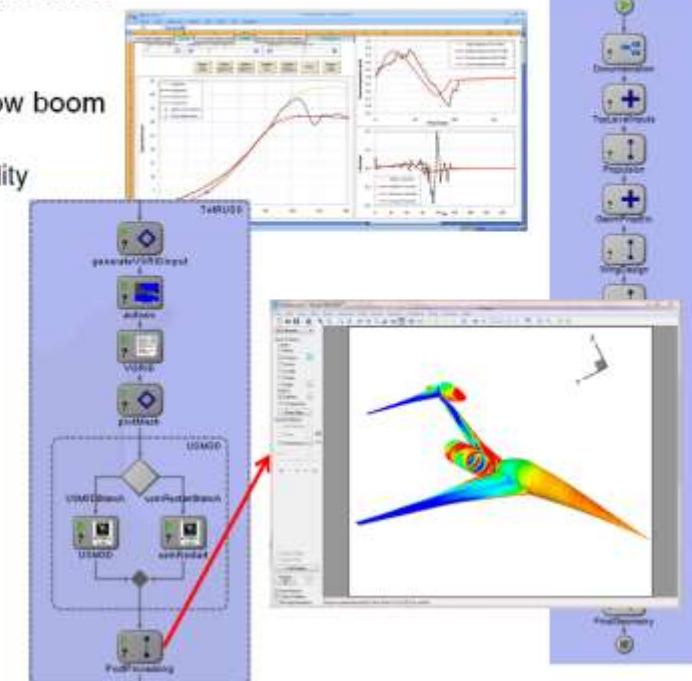
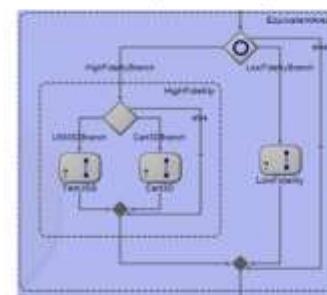


- Quiet supersonic aircraft design program for low-boom, low-noise design
- Based on multifidelity, multidisciplinary design approach and MDO framework

## A<sub>e</sub> Based Low-Boom Design Assembly

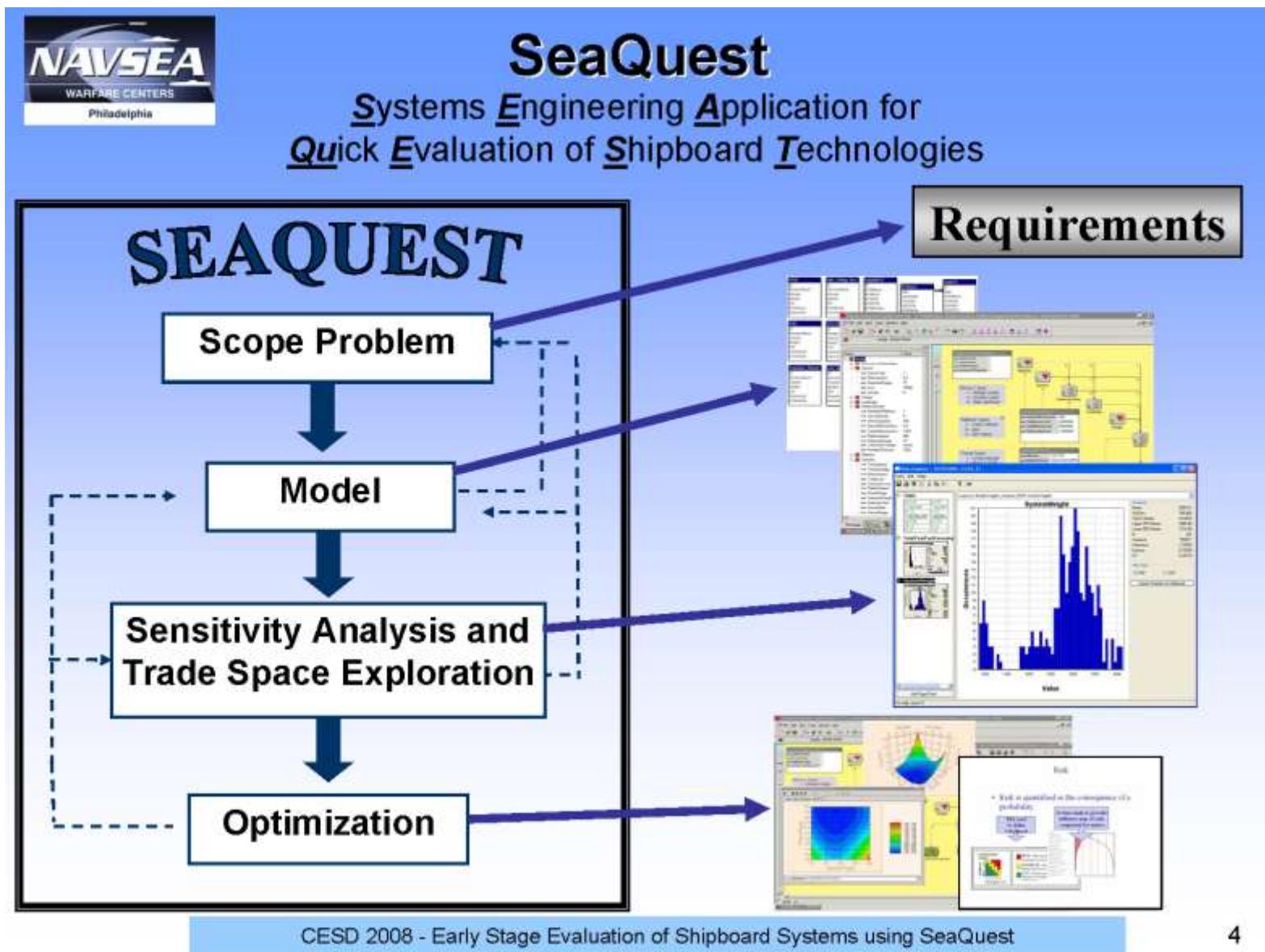


- Automated or user interactive mode
  - A<sub>e</sub> target development
  - A<sub>e</sub> Target matching
- Multiple fidelity levels for low boom shaping
  - Low, mixed and high fidelity
- Fully automated
  - Sourcing
  - Grid generation
  - Flow solution
  - Post processing



\* AIAA 2011-465 "Integration of Multifidelity Multidisciplinary Computer Codes for Design and Analysis of Supersonic Aircraft"

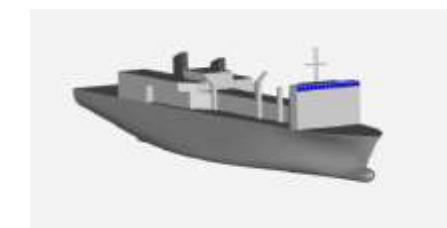
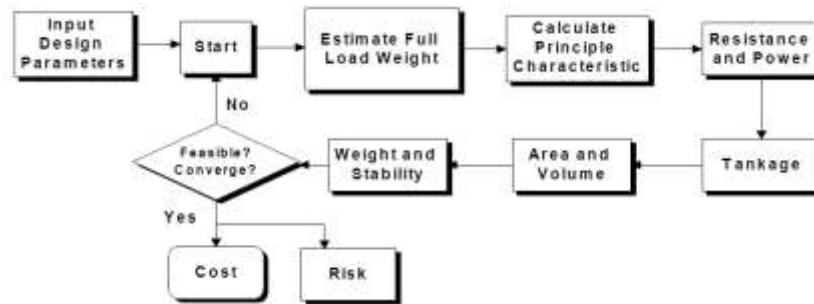
# NAVAEA



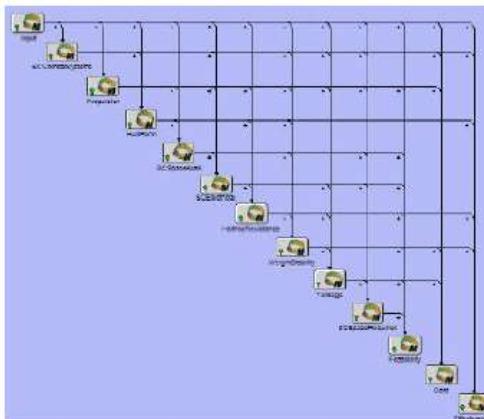
# Virginia Tech CISD Case Examples

- CISD (Center for Innovation in Ship Design)  
Dr. Alan Brown, Department of Aerospace & Ocean Engineering
- 적용사례, 논문, 보고서 : <http://www.dept.aoe.vt.edu/~brown/VTShipDesign/VTShipDesign.htm>

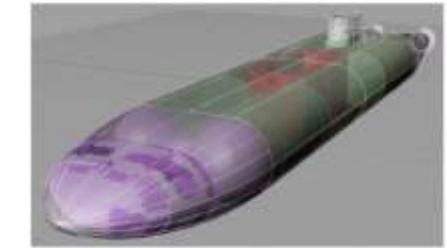
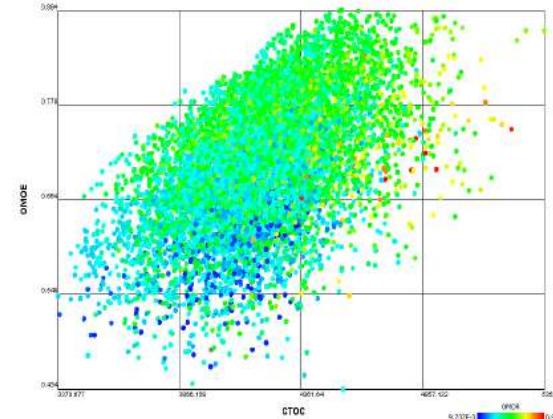
Ship Synthesis Model:



Integrated Process Model

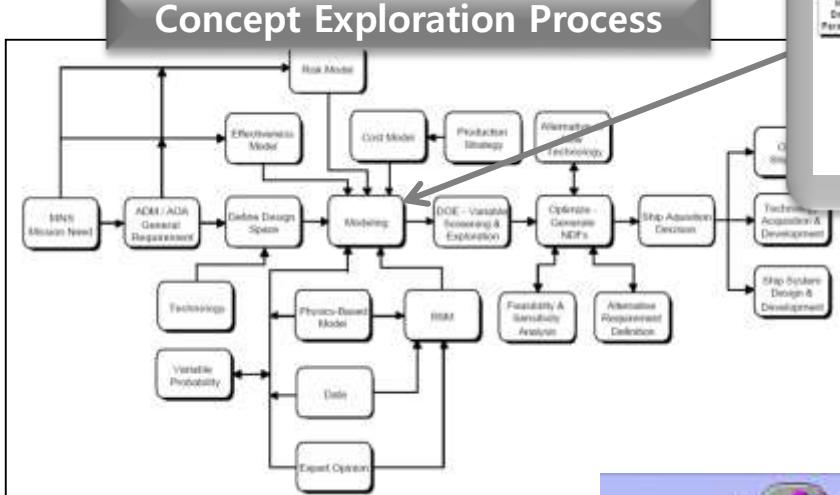


Pareto Front by MOGO

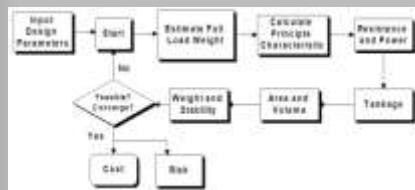


# Multi-Disciplinary & Multi-Objective Optimization for Ship Design

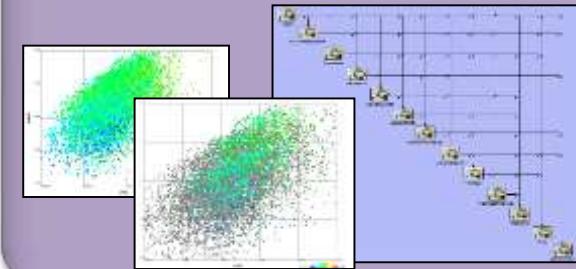
## Concept Exploration Process



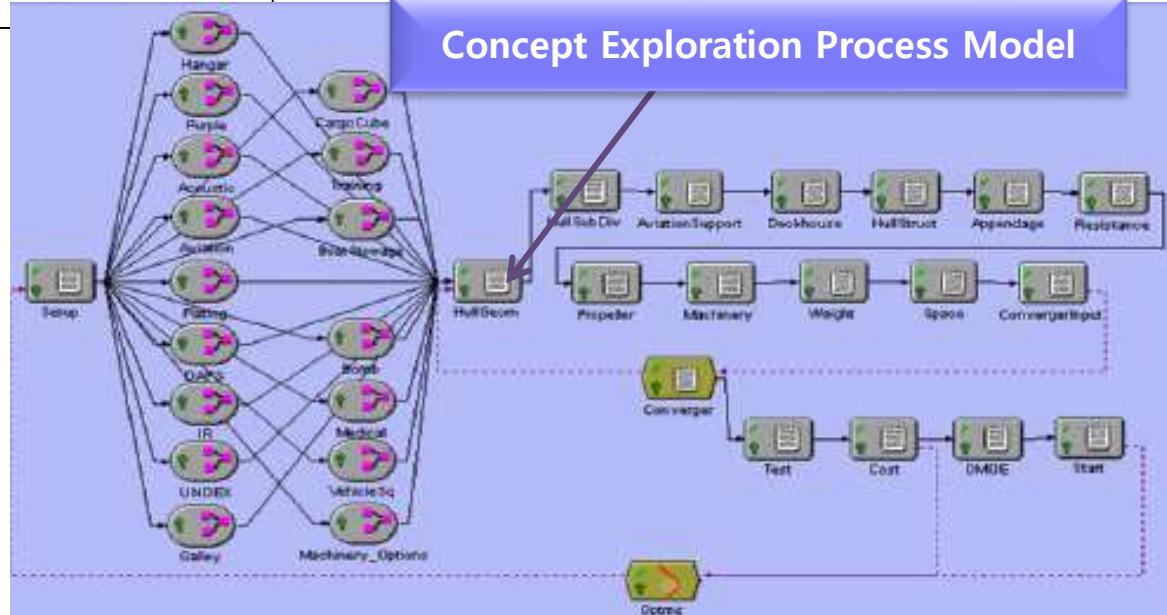
## Ship Synthesis Model



## Integrated Synthesis Model



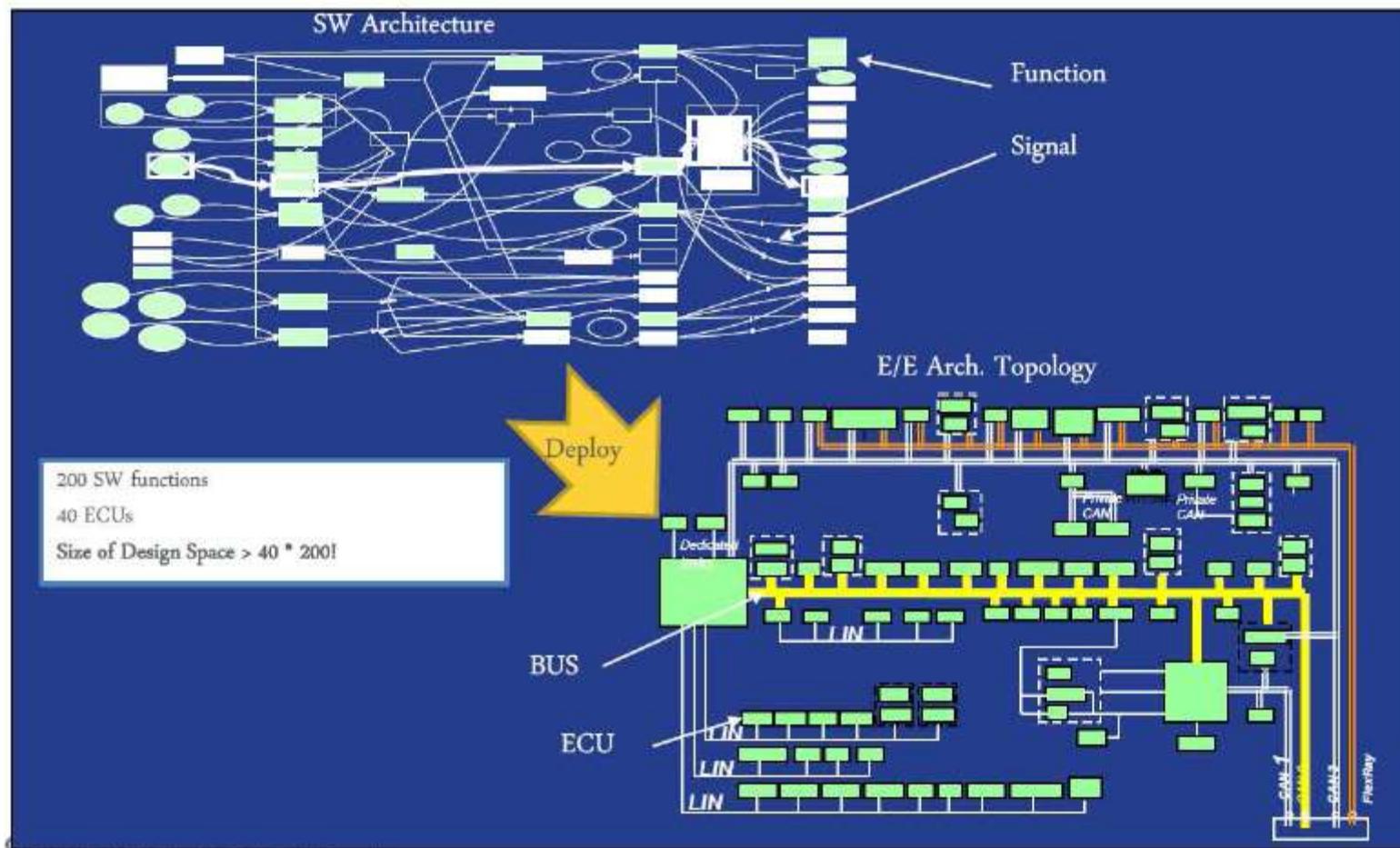
## Concept Exploration Process Model



# GENERAL MOTORS



## IN-VEHICLE SW/HW ARCHITECTURES COMPLEXITIES – LOGICAL VIEW



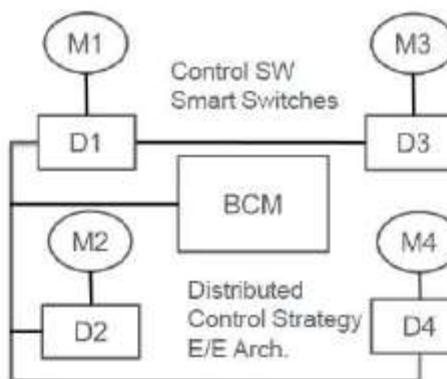
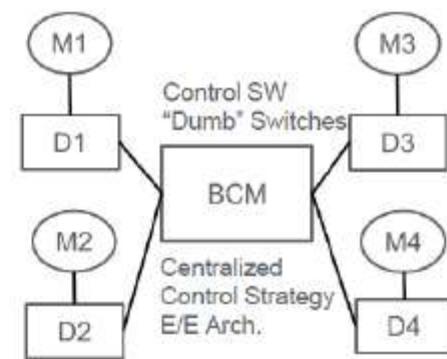
# GENERAL MOTORS

## CASE STUDY: POWER WINDOW DESIGN



Questions for the trade-study:

- Which design is more cost effective while feasible?
- Would a wireless communication link be a benefit?



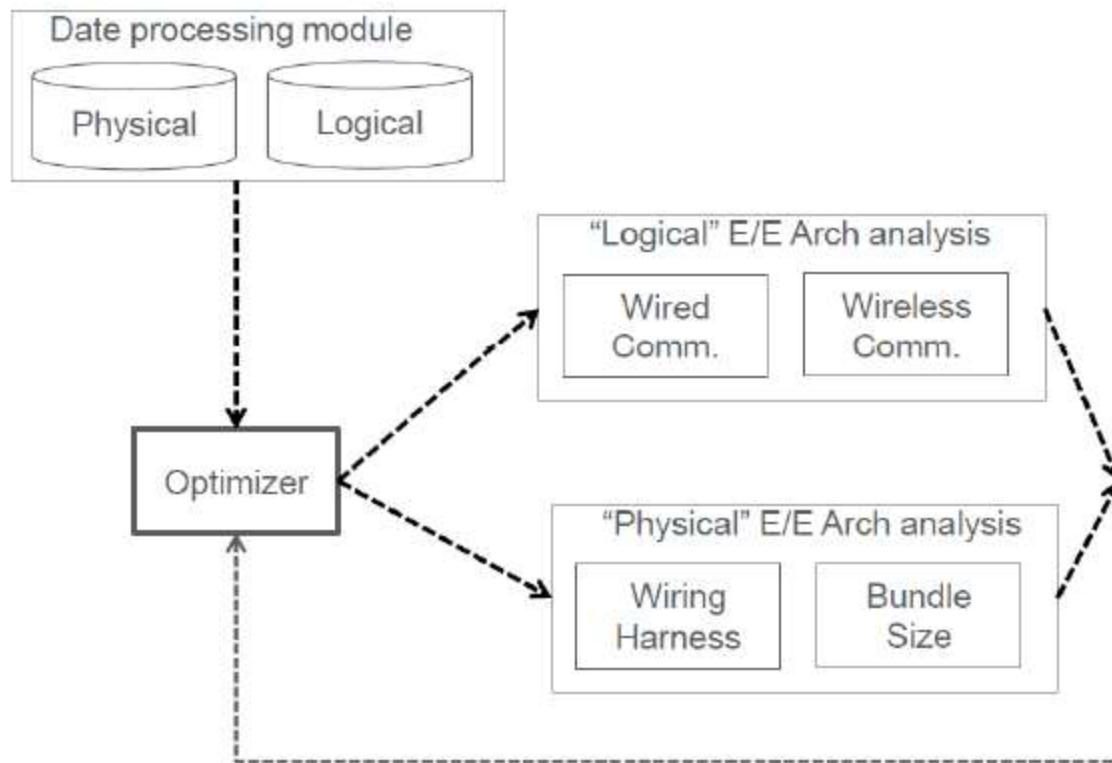
Tool requirements:

- Architecture topology exploration
- Serial bus load analysis
- SW allocation

# GENERAL MOTORS



## WORKFLOW FOR TRADE-STUDY



- **Objectives**

- Min: cost, wired communication link load/latency
- Max: wireless communication reliability

- **Constraints**

- Quality of service (response time, packet loss rate)
- Wire resistance
- Harness device allocation
- E/E Architecture Topology
- Wired communication link load

- **Design variables**

- Architecture Topology & Software Allocation: topology includes ECUs/devices and ways of communicating (wireless or wired); selection of wireless technologies (Bluetooth or RF)
- Wire Size: depends upon load constraints
- Wire Length: depends upon device allocation to harness

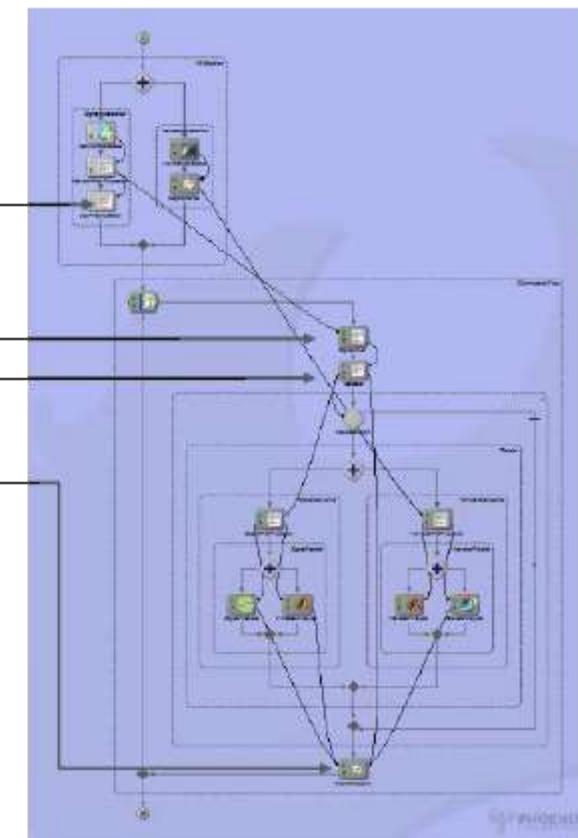
# GENERAL MOTORS

## (SOME) WORKFLOW DETAILS



### Optimization Related Scripts

- Optimization Preprocessor
  - Generates signal/ECU allocation alternative
  - Sets initial signal/ECU allocation
- Signal Mixer
  - Builds the network message
  - Passes wireless on/off
- Validator
  - Validates configuration
- Optimization Postprocessor
  - Merges wired/wireless results



### Third Party Wrapped tools

- Mentor Graphics Capital
- IBM Rational Rhapsody
- SymTA/S
- MatLab
- NX

# GENERAL MOTORS



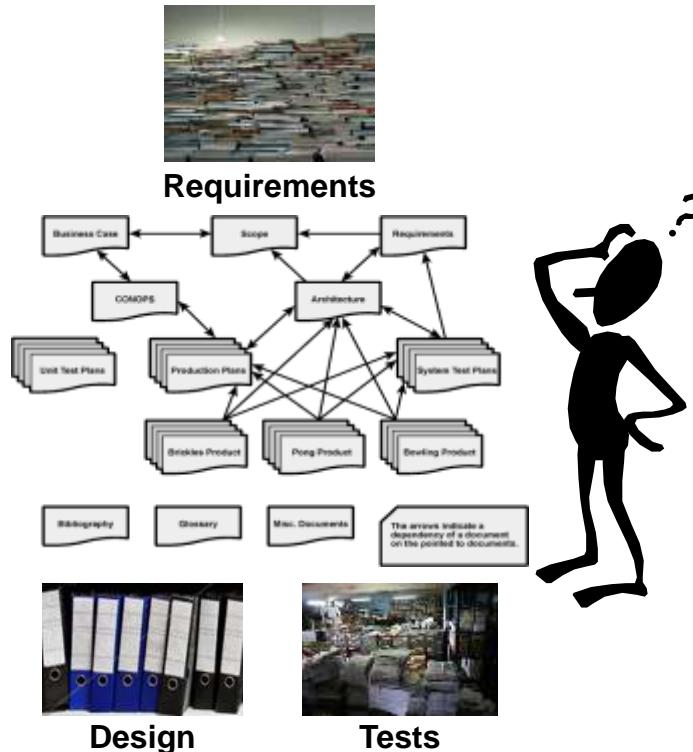
## CONCLUSIONS

- E/E Architectures are increasingly complex
- Need to reduce complexity to
  - Ease Testing
  - Reduce System and Part Cost
  - Increase Reliability
  - Strive for best Quality
- We have shown our capability and tool strategy
  - Optimization and Automated Workflows can play a major role in the strategy
- We have shown a use case study to support automated trade-study
- We strive to continue introducing system level trade-studies in our engineering development processes

# Introduction to MBSE Pak

# Traditional System Engineering

## Document-Based approach (Traditional)

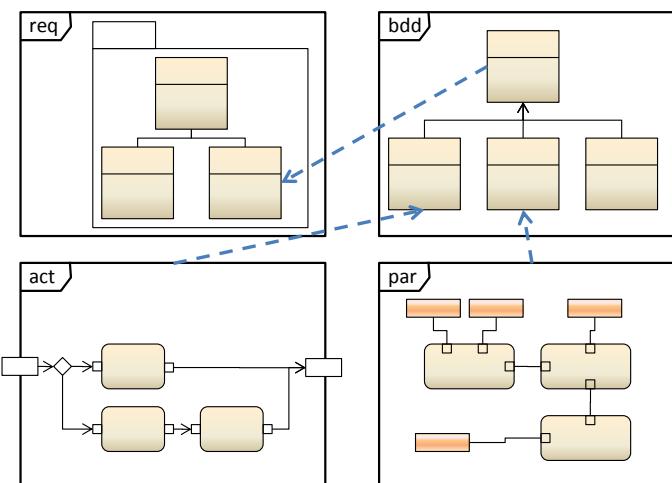


- 기존 문서기반 시스템 설계의 한계 인식
- 데이터 관리 문제
  - 각 분야별로 분리된 데이터 관리 시스템
  - 설계 정보의 공유가 어려움
  - 데이터 관리 및 데이터 간 연관성 파악과 추적에 어려움
- 복잡한 시스템 구성 문제
  - 개별적 관리로 인한 데이터 손실 우려
  - 급격히 증가하는 데이터의 체계적 관리에 어려움
  - 세부적인 복잡한 형태의 시스템의 경우, 특히 시스템 환경 구성 및 관리에 어려움

문제해결을 위한 Solution 필요!

# Model-Based Systems Engineering (MBSE)

## MBSE (Model-Based Systems Engineering)



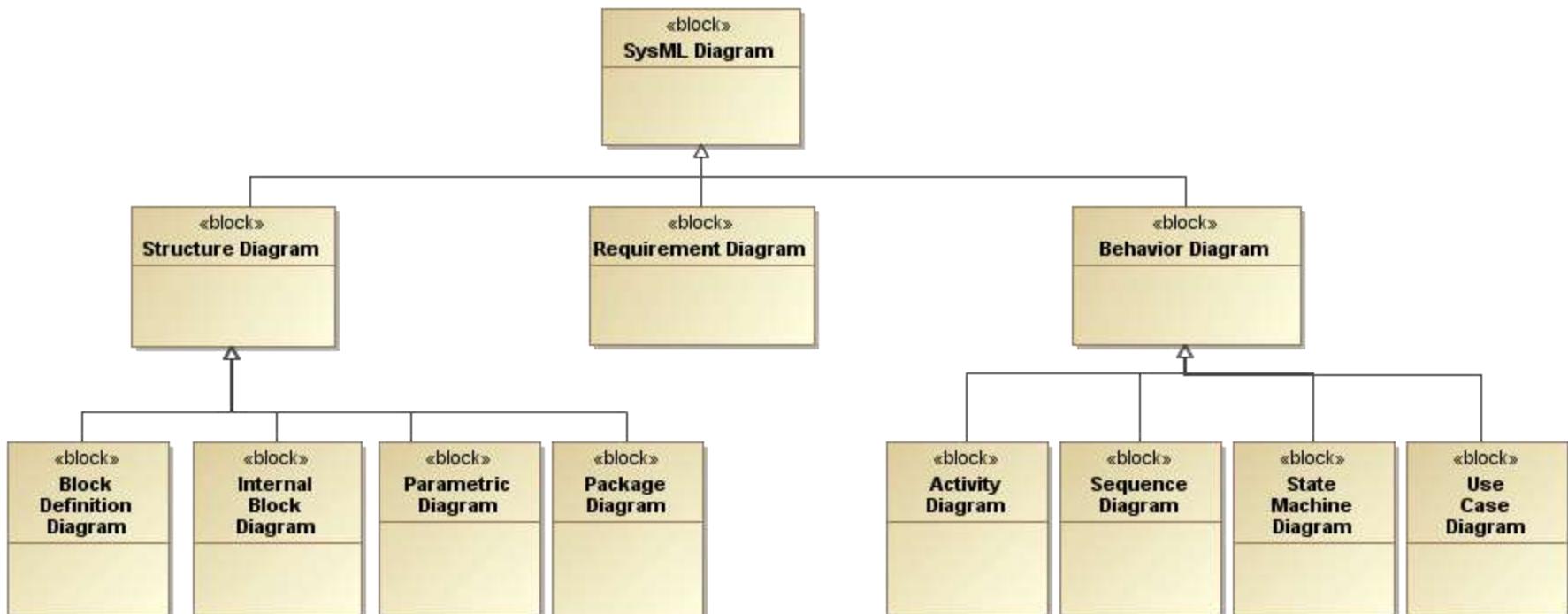
- Improve Understanding
- Improve Communication
- Reduce Inconsistency and Error

- **MBSE 방식**
  - 제품의 개념설계에서부터 생산 및 운용, 유지까지 모든 단계에서 필요로 하는 시스템 요구와 설계 및 해석, 확인 및 검증 과정을 MODEL 기반으로 접근하는 방식
  - 관련된 각각의 데이터를 하나의 모델로 구성하여 시스템 구조를 가시화
  - 방대한 양의 정보를 체계적/효율적으로 관리
  - 효과적인 데이터 추적 가능
  - 시뮬레이션 기법 적용을 통한 프로토타입 제작 최소화
- **설계 주기 단축 및 정확한 설계정보를 통한 설계 오류 감소**
- **설계 그룹 간 이해도 및 협업 효율 증가**

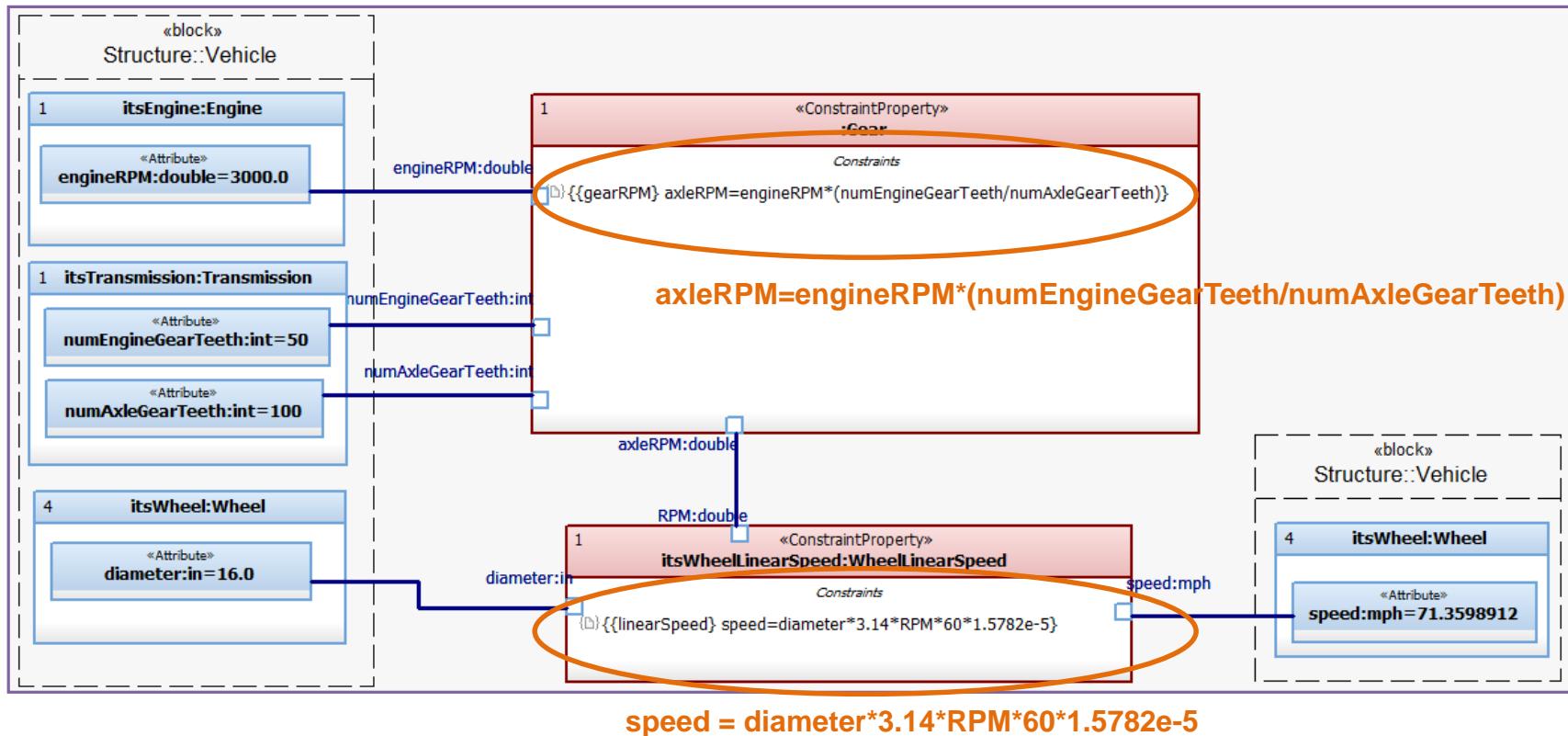
*The trend toward MBSE is like the trend toward CAD of previous years.*

# SysML (System Modeling Language)

- **SysML – System Modeling을 위한 범용 모델링 언어**
  - OMG(Object Management Group) 표준 언어
  - UML(Unified Modeling Language)의 확장 개념
  - 설계 요구조건, 설계 및 해석 환경, 검사 및 유효성 등의 다양한 조건을 Diagram(SysML Block)으로 구성하여, 시스템의 구조화 및 가시화 지원
  - 설계 변수간의 관계 파악에 용이



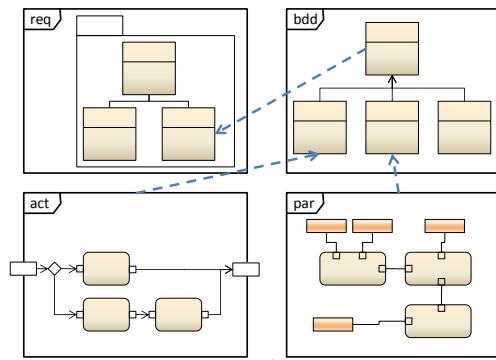
# SysML Parametric Diagram



- Parametric Diagram을 이용해 매개변수 간의 관계를 정의
- 변수간의 관계를 파악할 수 있는 간단한 방정식 사용 가능
- 단, 상용 코드와의 연동이 복잡하고 어려움

# Gap Between Systems Engineering & Engineering Analysis

- Tools, models, and terminology are different
- SysML models are descriptive in nature
- The gap causes inefficiencies and errors

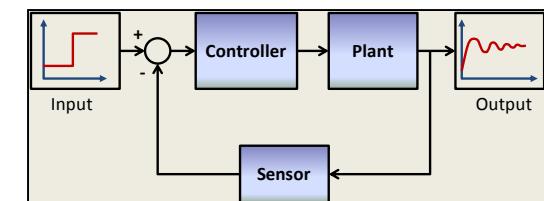
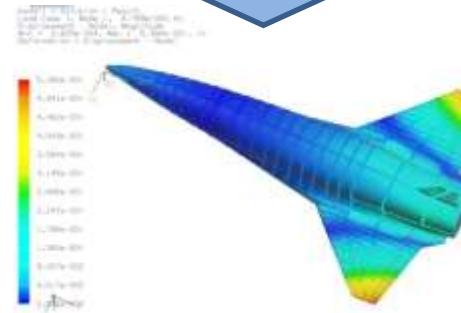
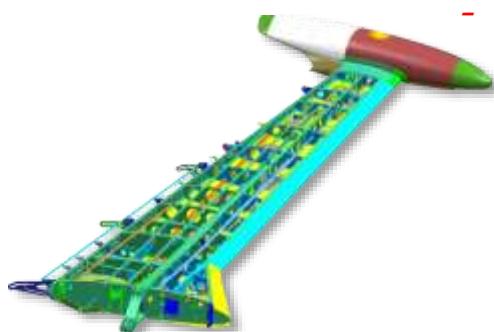


**Systems  
Engineering  
Model**

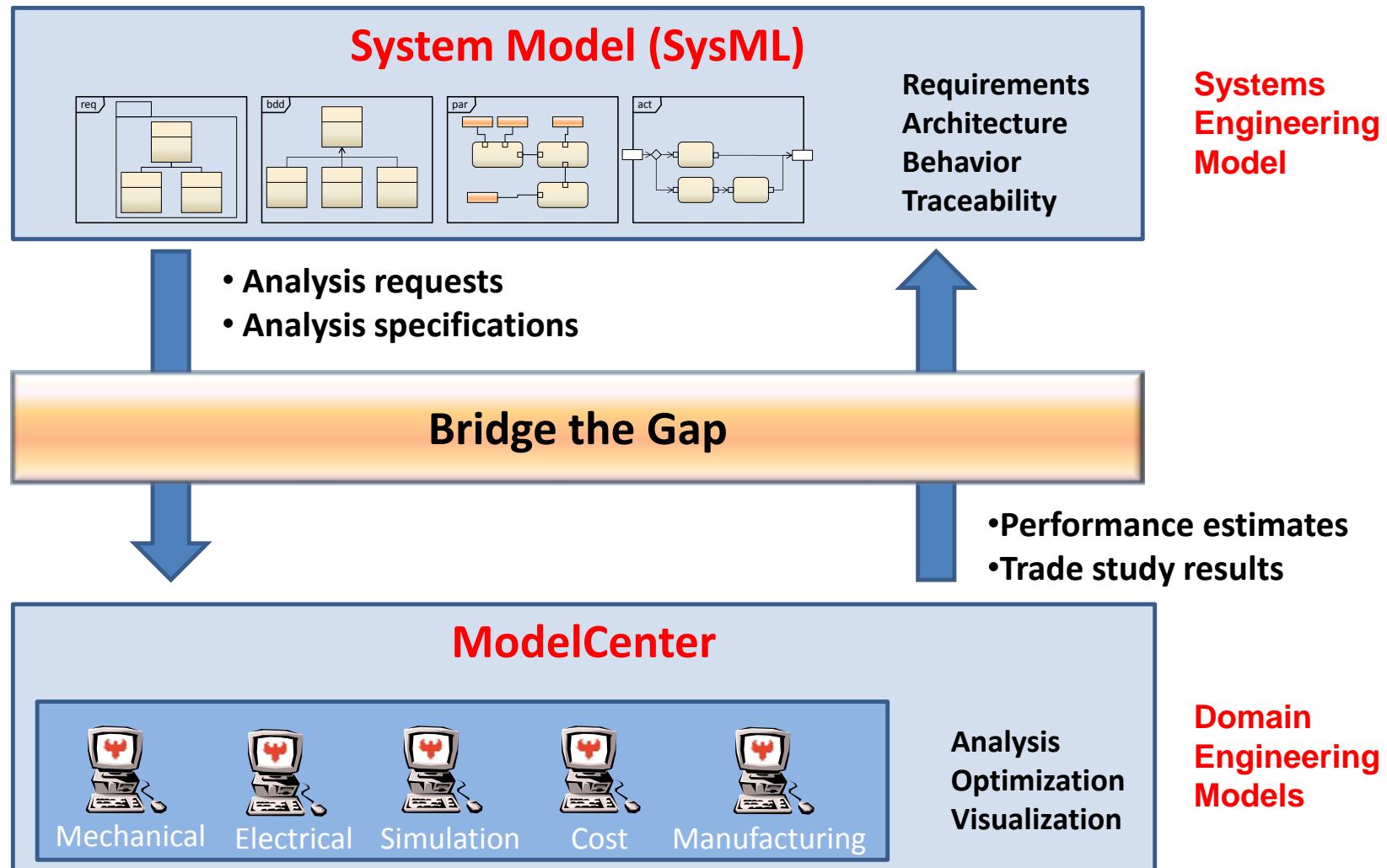
*- Error Prone  
- Slow  
- Expensive  
- Unresponsive to Changes*



**Domain  
Engineering  
Models**



# Connect SysML with Engineering Analysis



# MBSE Pak

- **MBSE Analyzer**
  - Accessible from within MBSE Tool (Rhapsody® or MagicDraw®)
  - Generate ModelCenter Models from SysML Parametric Diagrams
- **MBSE Plug-In**
  - Accessible from within ModelCenter
  - Read SysML Parametric Diagrams (Rhapsody® or MagicDraw®) and Automatically Build a ModelCenter Executable Model
- **MBSE Pak includes both MBSE Analyzer and MBSE Plug-In**

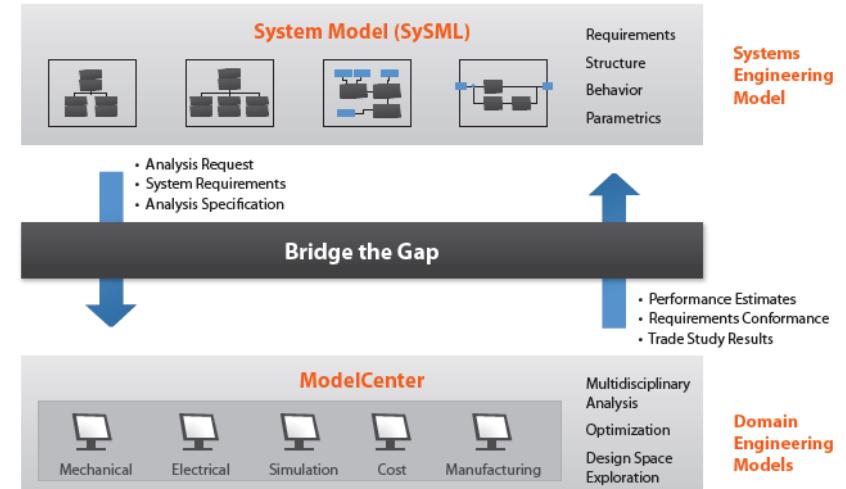
## MBSE Pak



Link MBSE Tools with ModelCenter so that systems engineers and domain experts can more easily exchange information, check requirements conformance, and perform trade studies throughout the design process.

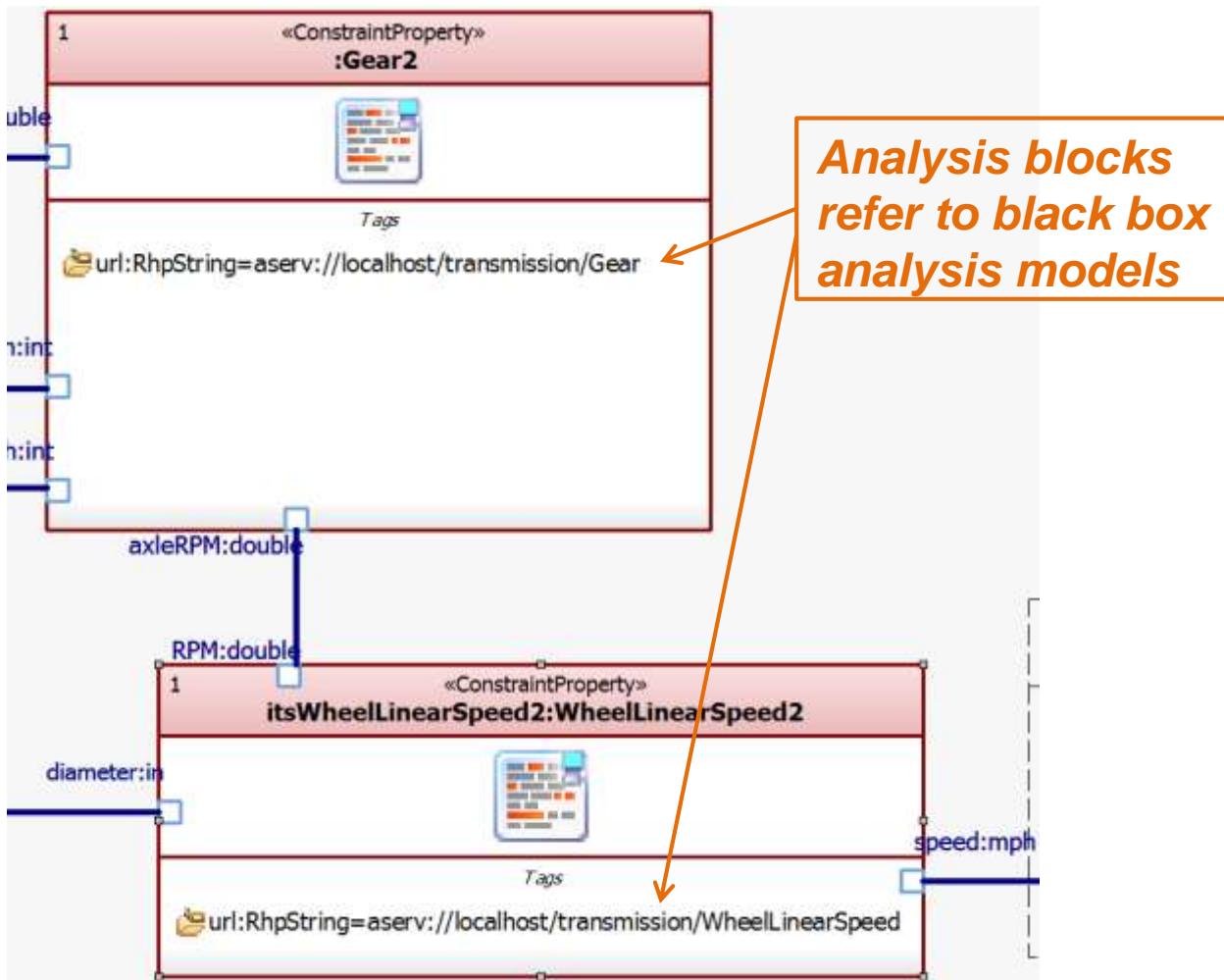
Connect your system model with a software environment that integrates and executes analytical simulation tools and performs trade studies. Systems engineers are increasingly using model-based systems engineering (MBSE) practices and tools in place of traditional document-based approaches to define and track all aspects of a system as it is being developed. MBSE software tools that utilize graphical modeling languages such as SysML are often used to define system models.

MBSE tools like Rhapsody and MagicDraw are generally very limited in their ability to easily link the system model to the analytical software applications that domain experts use to predict design performance and cost. As a result, systems engineers and domain experts are forced to rely on ad-hoc communication and manual translation of data. This process is both error-prone and time consuming, and significantly limits the number of design configurations that can be evaluated in the time allotted.



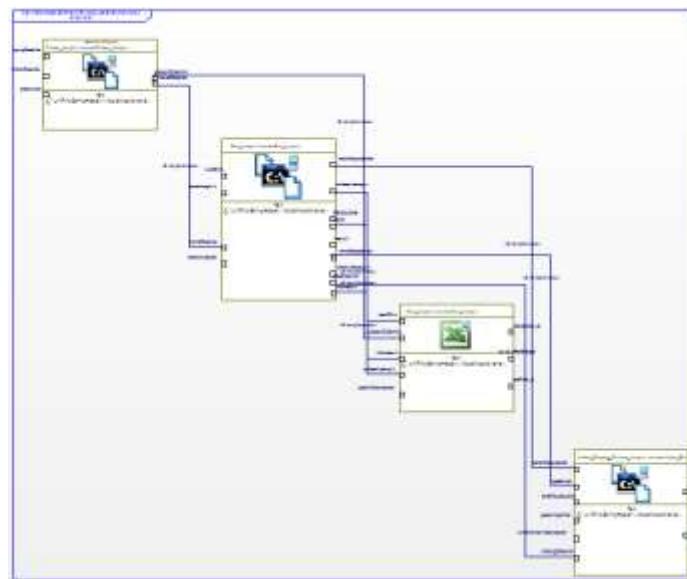
# Extension of Parametric Diagram

- Rhapsody/MasicDraw 상의 MBSE Analyzer 기능을 통한 상용 해석 Tool과의 연동 기능 제공(ModelCenter 활용)



# Automatic Generation of Analysis Model from SysML Model

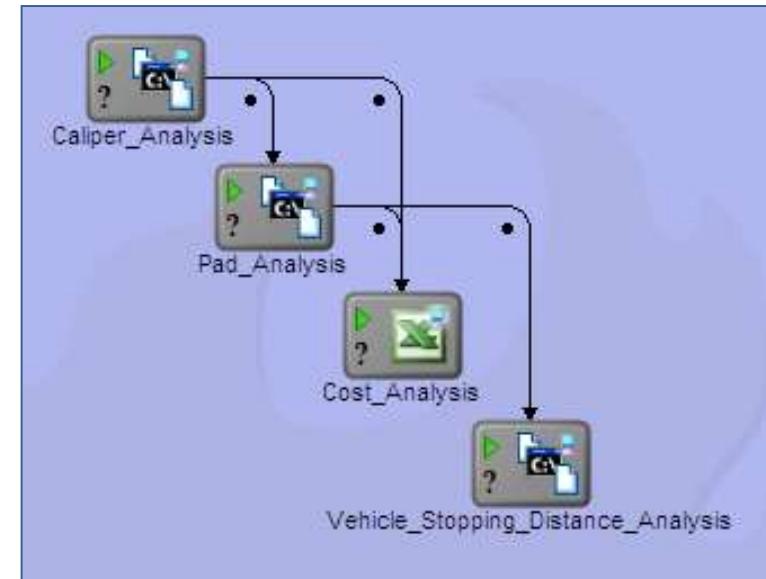
SysML Parametric Diagram  
in Rhapsody or MagicDraw



Automatic  
Generation

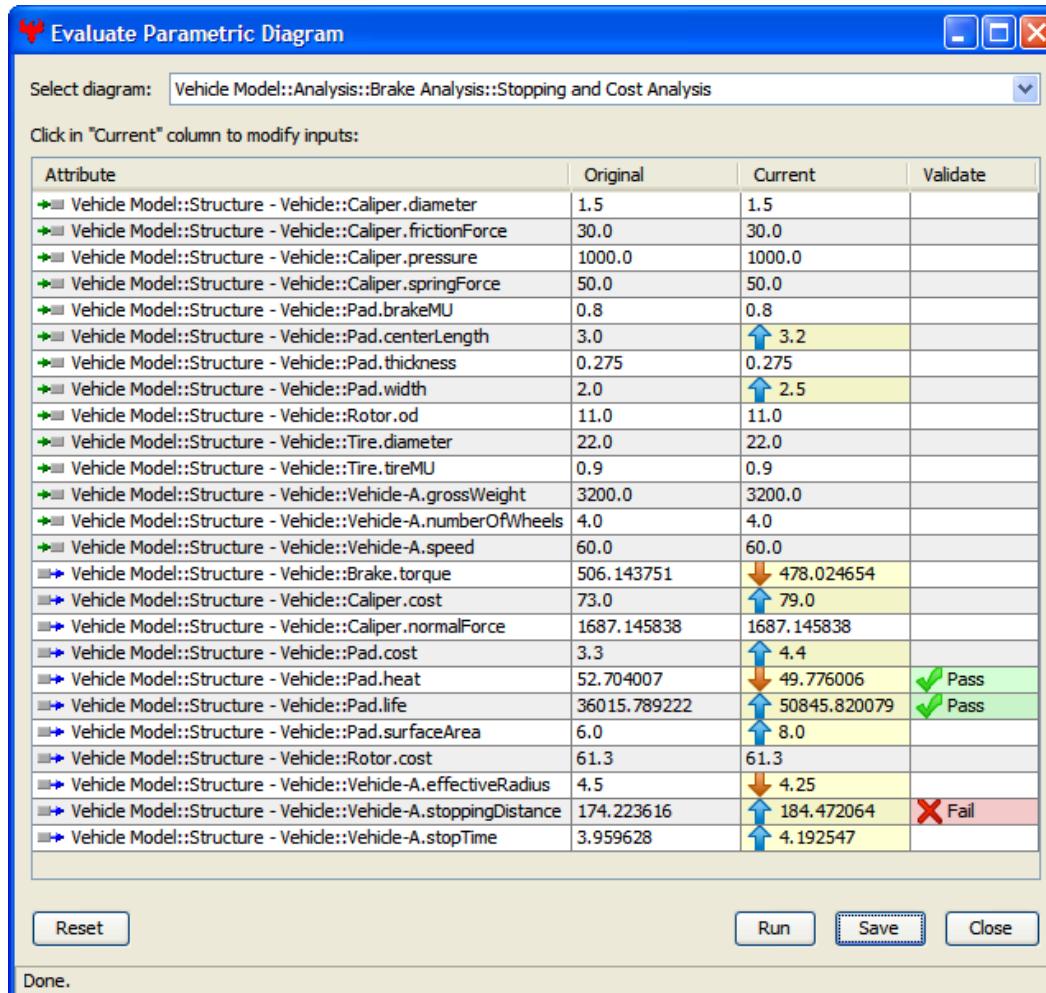
Analysis  
Results

Executable Analysis Model  
in ModelCenter



- SysML을 이용한 시스템 설계 및 변수간의 관계 정의
- 프로세스의 자동화를 위해 ModelCenter 모델로 변환 (MBSE Plug-In)
- ModelCenter 상에서 수행된 해석의 결과값을 자동으로 SysML 모델로 업데이트

# Evaluate System Configuration



- **SysML Parametric Diagram 실행을 위한 그래픽 도구 제공**
- 정확한 해석 수행을 통해 SysML 시스템의 구성 평가
- 해석 결과와 요구사항의 비교를 통해 도출 결과에 대한 평가 및 검증 자동화
- 해석 결과를 통해 SysML 모델이 자동으로 업데이트

# Requirements Modeling & Conformance Analysis

- 요구사항을 저장 및 공유하는 웹기반 데이터베이스 활용 (ex. IBM DOORS)
- 저장되어 있는 요구사항을 SysML 모델로 Import 가능
- 요구사항에 대한 평가를 자동을 수행하기 위한 각 변수 별 Lower/Upper Bound 지정
- 요구사항에 적합하지 않은 결과값을 자동으로 강조
- 즉각적인 문제 확인 및 해결 방안 탐색 가능

ID	Requirement	Priority	LowerBound	UpperBound	EqualsTo	Units
4	<b>1.1 Stopping Distance</b> Four braking wheels shall be capable of stopping the vehicle from 60 miles per hour in less than 180 feet.	True	high	0	180.000000	ft
5	<b>1.2 Brake Heating</b> Braking at 60 miles per hour shall not generate more than 53 kW of heat at each wheel.	True	high	53.000000		kW
6	<b>1.3 Brake Pad Life</b> Brake pads shall have a projected life of at least 40,000 miles under normal driving conditions, as per industry standard assumptions.	True	high	40000.000000		
2	<b>2 Vehicle Properties</b>	True	high			
10	<b>2.1 Vehicle Weight</b> The vehicle weight shall be equal to or less than 3200 pounds.	True	high	3200.00		
11	<b>2.2 Tires</b> The tires shall have a 22-inch rolling diameter	True	high			
12	<b>2.3 Rotor Diameter</b> The brake rotors shall have a 11-inch diameter.	True	high			

**Vehicle**

4      **wheelAssy:Wheel**

1      **brake:Brake**

1      **pad:Pad**

«Attribute»  
life.mi=36015.789222

Vehicle Model: Requirements\_1 Performance

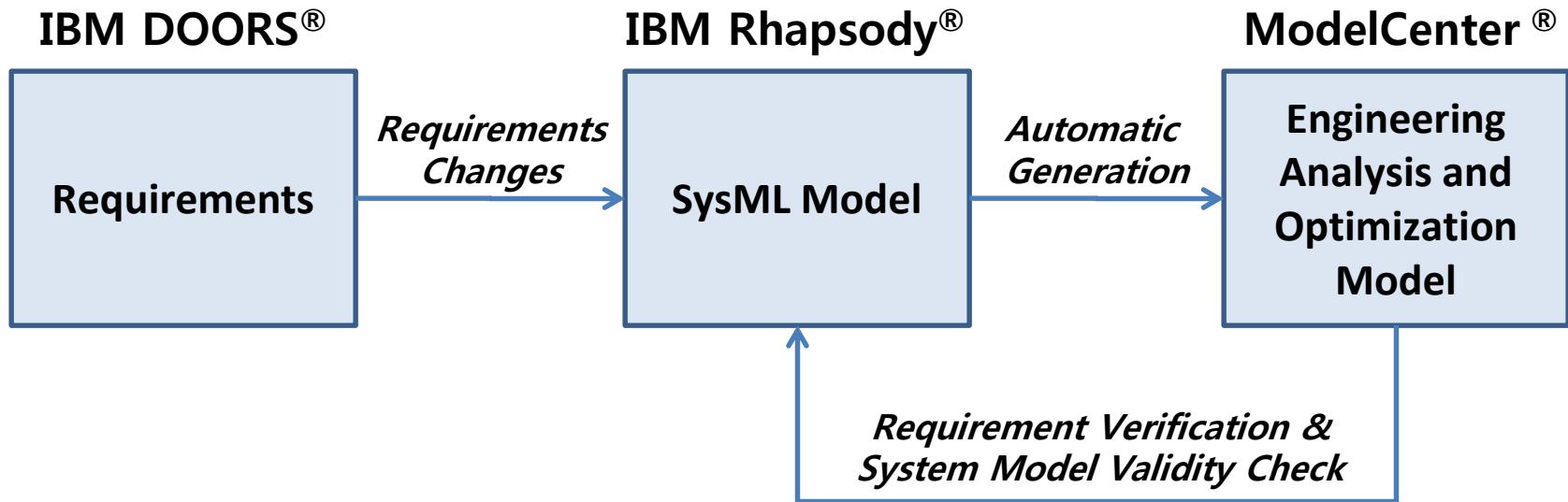
**X**

Brake pads shall have a projected life of at least 72,000 miles under normal driving conditions, as per industry standard assumptions.

Tags

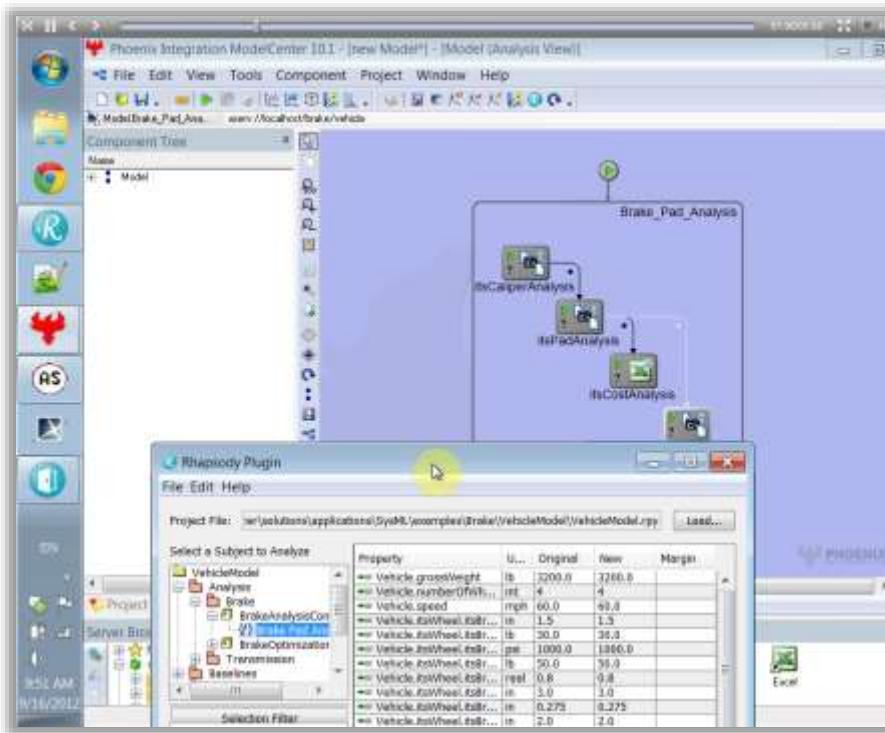
- status.VerdictKind
- LowerBound.RhpString=72000.000000
- Priority.RhpString=high
- Units.RhpString=mi

# Enable Agile Response to Requirements Changes

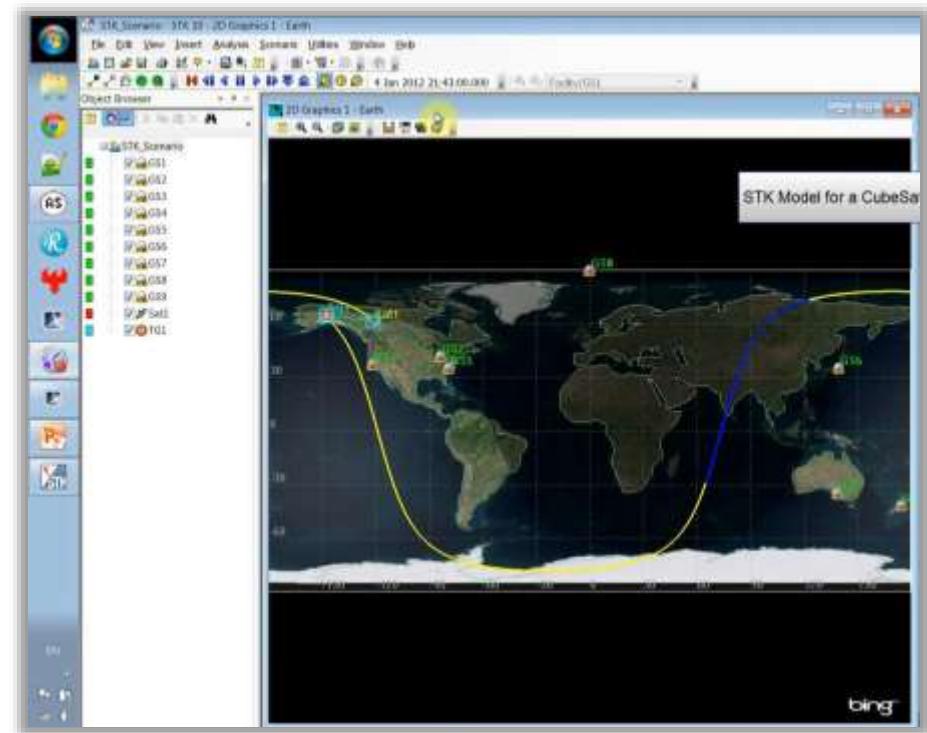


- 데이터베이스, SysML Model, ModelCenter가 유기적으로 결합
- SysML Model과 Analysis Model을 통해 변경된 내용을 자동으로 업데이트
- 요구사항 변경에 따른 전반적인 시스템 영향을 자동으로 평가
  - 요구사항 만족도, 재설계 및 재해석여부 등
- 요구사항 도출을 위한 자동화된 방법 적용 가능(Trade Study 수행)
- 기존 방식 대비, 새로운 사항이 반영된 시스템 모델을 쉽고 빠르게 도출

# MBSE Pak Demo



ModelCenter Rhapsody MBSE Pak



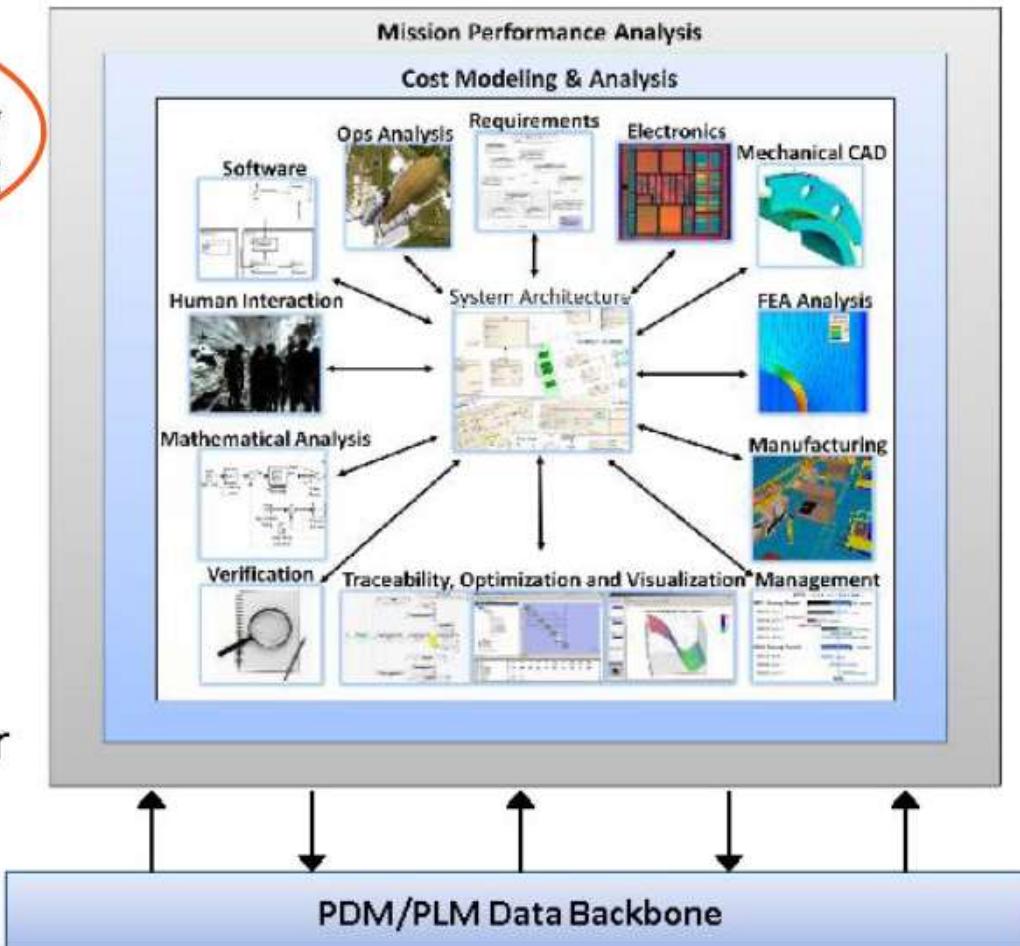
ModelCenter MagicDraw MBSE Pak

# Case Examples (ModelCenter MBSE Pak)

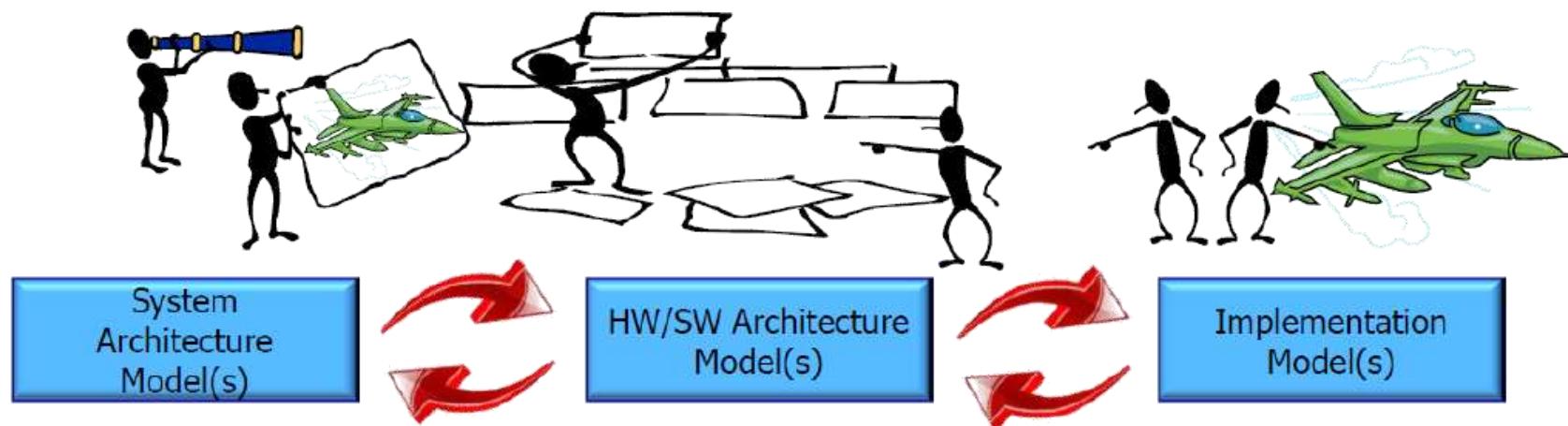


# SysML & PLM: Enabling the Vision

- A well defined System Architecture Model (SAM) is a key enabler for integrating and linking our engineering enterprise
- The SAM helps link requirements to logical and behavioral design
- Requirements can be fed into increasingly detailed levels of domain specific modeling
- Integration between Systems Engineering and the PDM/PLM backbone opens up a new frontier for integrated model-centric engineering



**MBE** is an approach to engineering that uses models as an integral part of the technical baseline that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle. (NDIA)

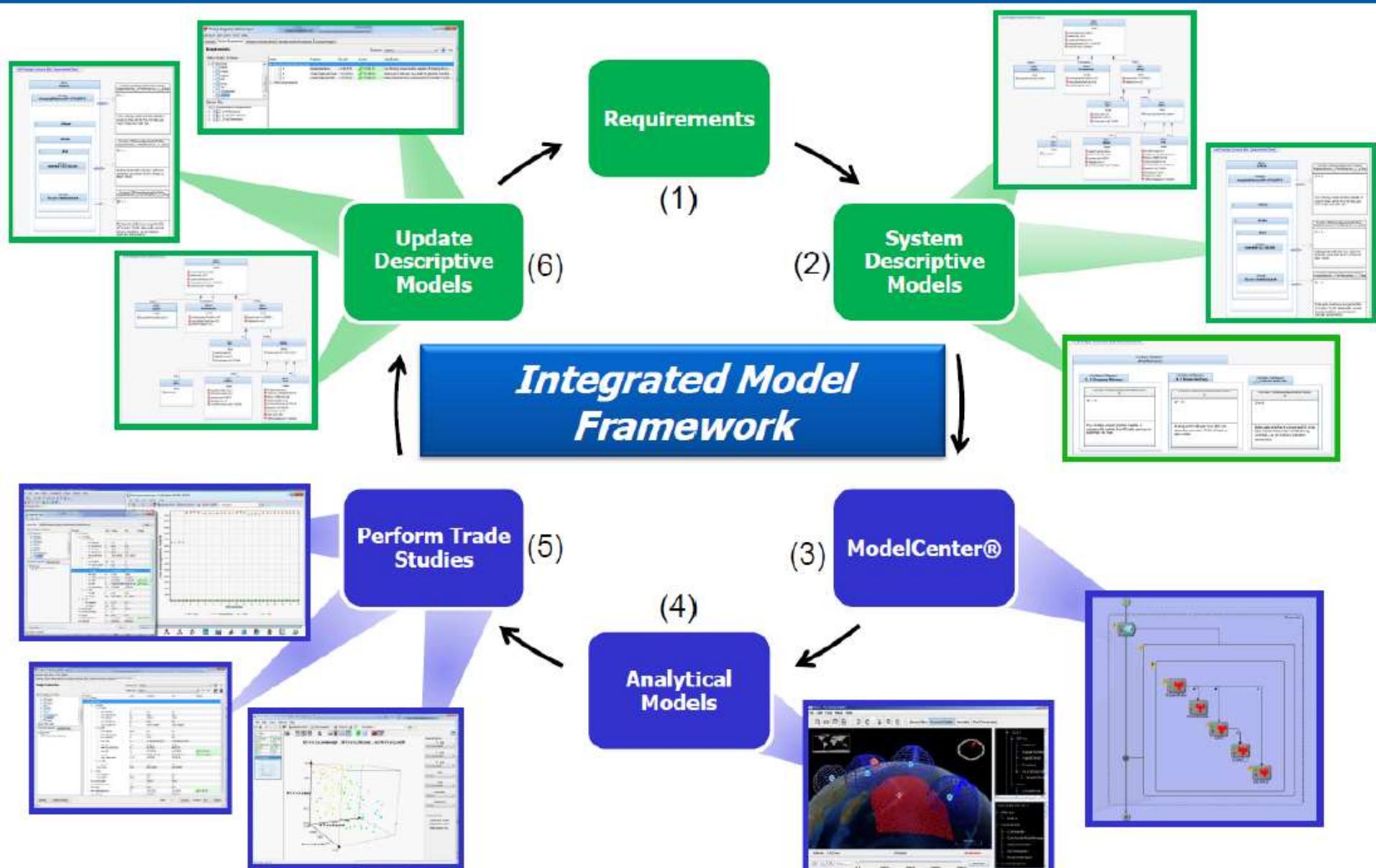


- Proven results at NGES with MBE with demonstrated
  - reduction in cost
  - reduction in schedule
  - Improvement in delivered quality
  - Higher customer engagement in the engineering process and satisfaction with the results

# Integrated Model Framework Example

NORTHROP GRUMMAN

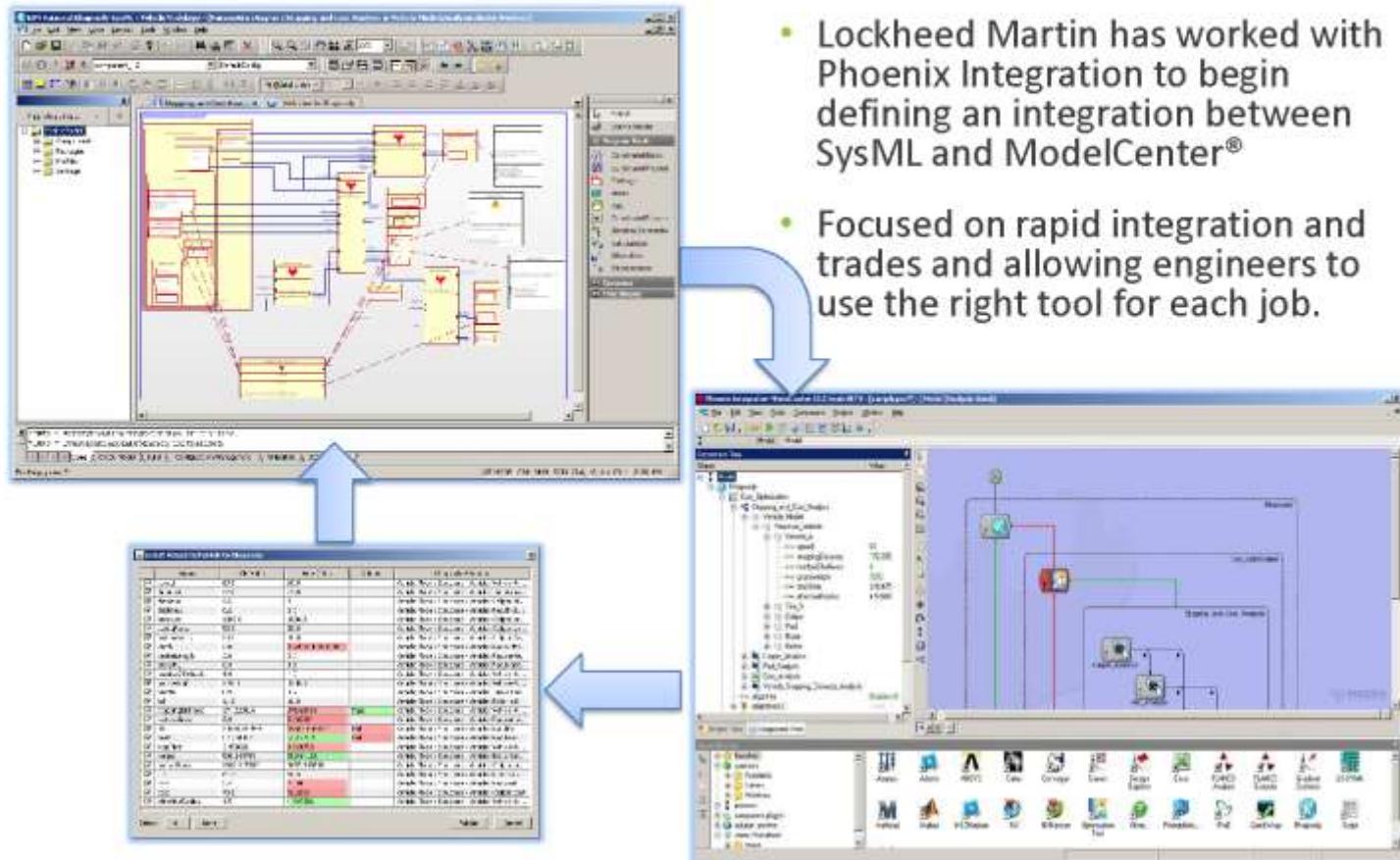
Descriptive to Analytical and Back



# Integrating Systems Architecture and Analytics



## Enhanced Tooling Beginning to Enable Integrated Model-based Analysis



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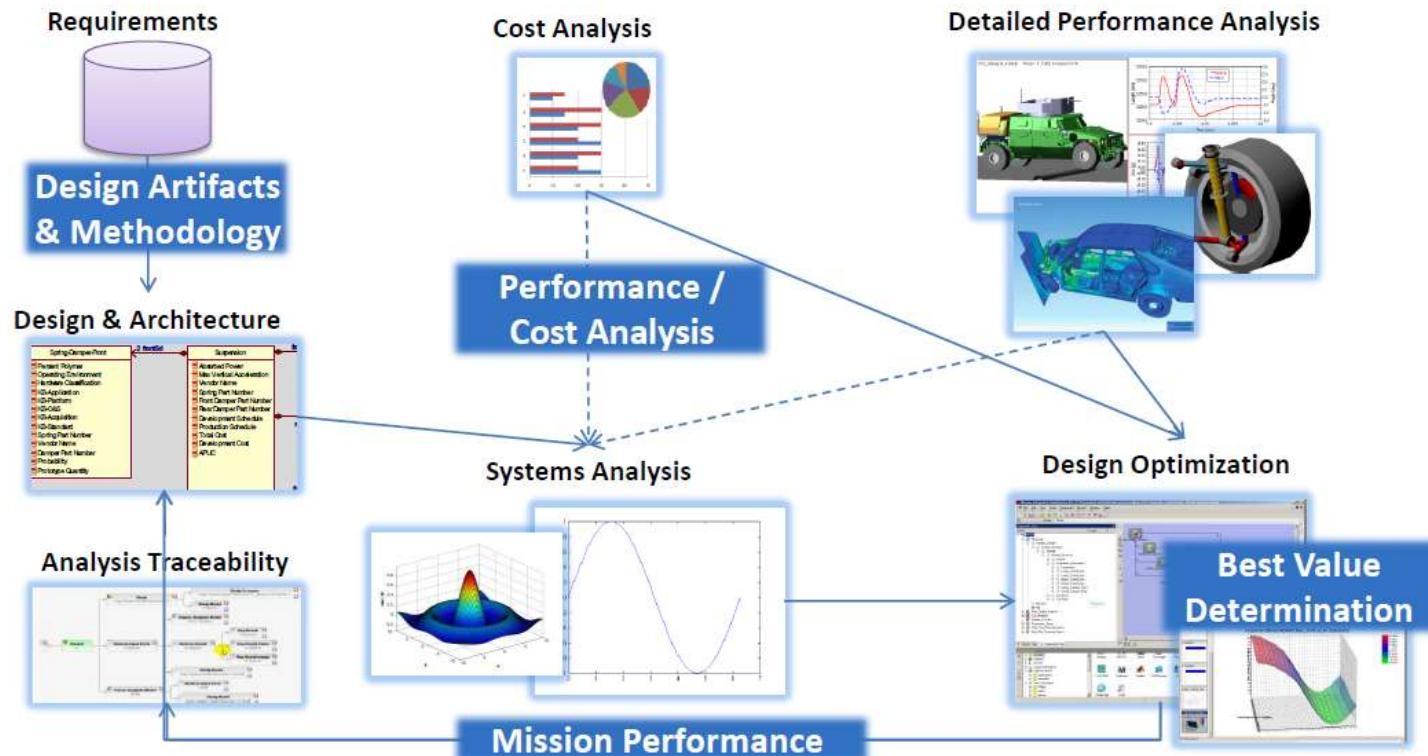
13

# Integrating Systems Architecture and Analytics



## Low Hanging Fruit: Integrated Multidisciplinary Analysis

ENGINEERING DESIGN  
**Forum2012**  
EMERGING SOFTWARE INNOVATIONS  
15 - 17 May | San Diego, CA | USA



# Integrating Systems Architecture and Analytics



## Initial Case Study: Balancing Performance, Acquisition Cost and Operational Cost

- Pilot Objective

- Elaborate the modeling capability to demonstrate robust integration of requirements, analysis and design

- Pilot Challenges

- Developing a Suspension System that meets ride and handling qualities under the full range of loading conditions at minimum cost and weight
  - Considering conventional, adjustable, active and position dependent shock absorber designs

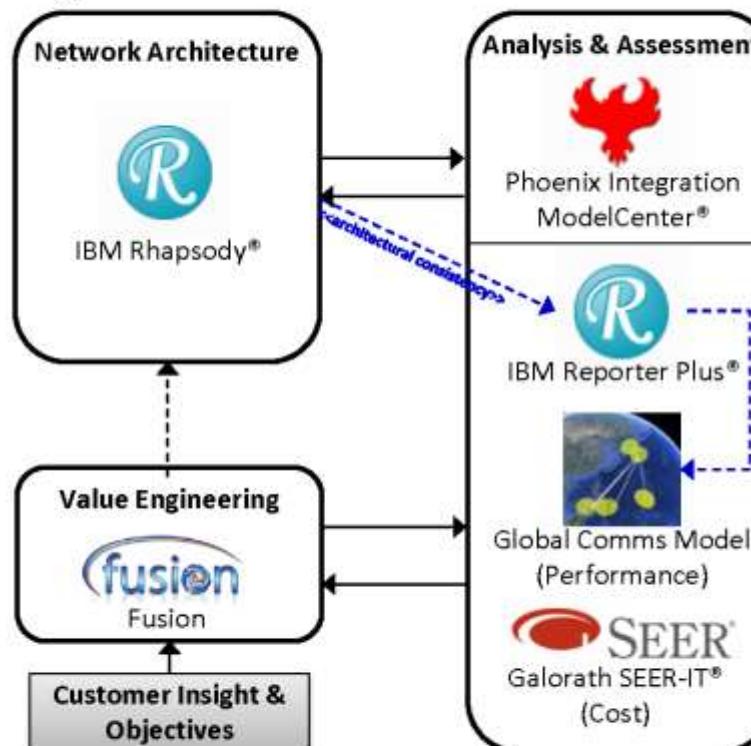
- Demonstrated integration of IBM Rhapsody®, SEER-H®, Excel®, Matlab® and MSC.Adams® using ModelCenter®
  - Focused on verifying an enhanced ability to investigate performance



# Integrating Systems Architecture and Analytics

LOCKHEED MARTIN 

## Expanding the Concept: Integrated Trade For Network Design



- Capture "As-Is" and alternative "To-Be" architectures using SysML in Rhapsody, ensuring a consistent, single baseline for network topology and architecture.
- Leverage an integrated model-centric analysis environment based in Model Center to analyze the cost and performance of solution alternatives driven directly from the Rhapsody based architecture
- Capture and manage customer value model within the Fusion toolkit to define optimal solution parameters
- Ensure confidence in approach based in analysis of alternatives and solid analytics

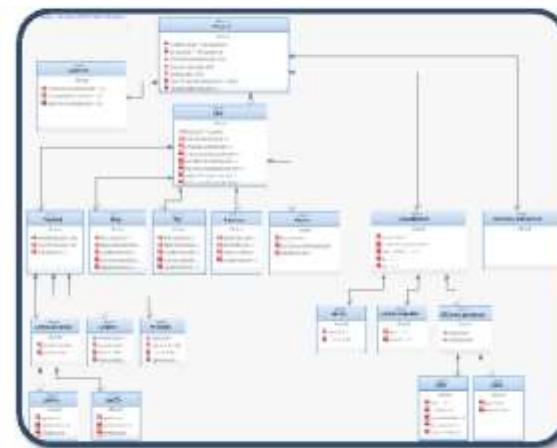
**Design, Manage & Optimize Best Value Network Architectures  
With an Integrated Toolkit**

# Perform Mission Simulation



## Example: Design

- Collaborative system analysis
  - Evaluate design effects on mission performance
  - Incorporate costs
- Inputs
  - SysML model in Rhapsody
  - Subsystem model in STK
  - Glueware from ModelCenter
  - Cost model from TruePlanning
- Results
  - Mission based design analysis
  - Comprehensive multidimensional analysis



Rational. software

phx ModelCenter®

TruePlanning®



# Perform Mission Simulation

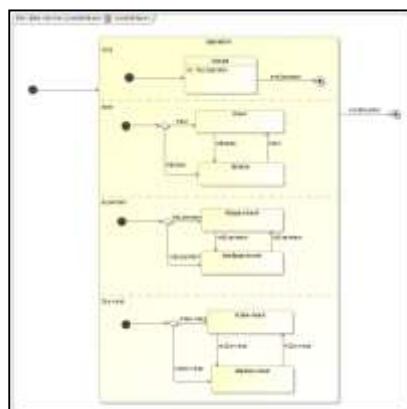
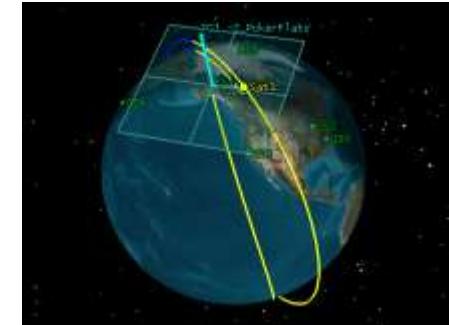
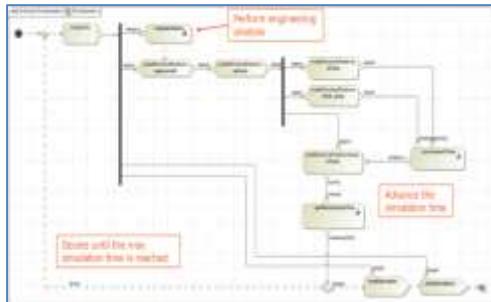


## Example: Design

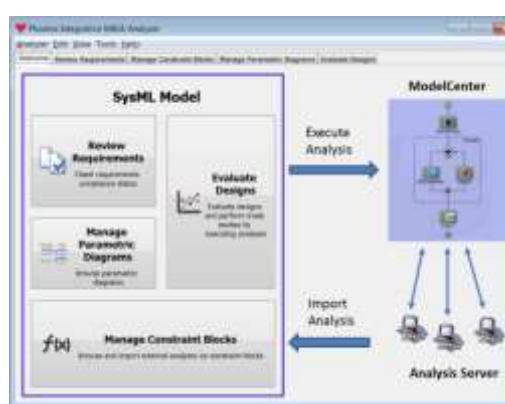
ENGINEERING DESIGN  
**Forum 2012**  
EMERGING SOFTWARE INNOVATIONS  
15 - 17 May | San Diego, CA (USA)



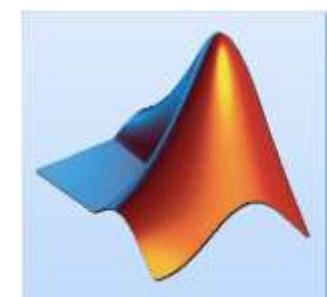
# Perform Mission Simulation



MagicDraw  
Cameo Simulation Toolkit  
(Behavioral diagrams)



MBSE Analyzer/ModelCenter  
(Parametric diagrams)



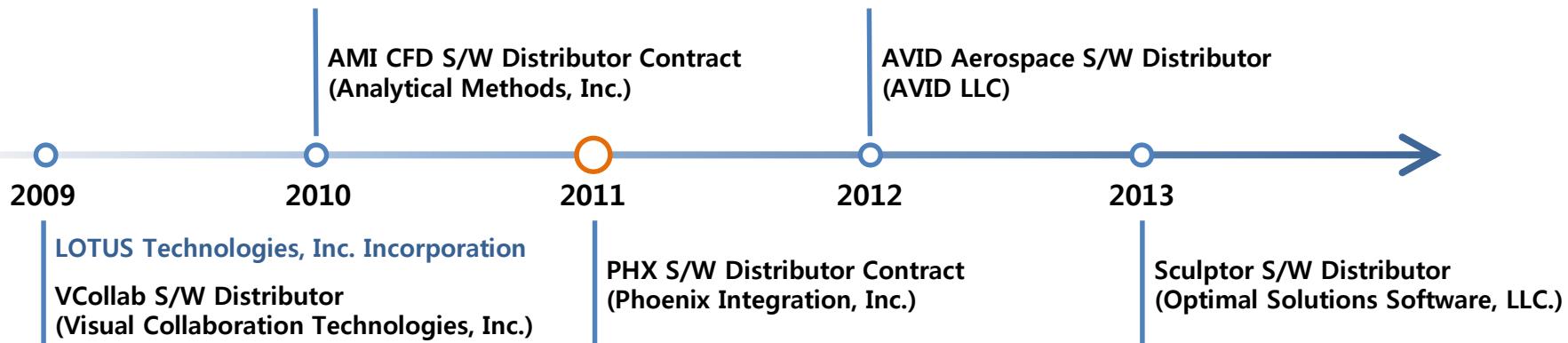
STK, Matlab, etc  
(Analytical models)

# 로터스정보기술(주)

# Introduction to LOTUS Technologies, Inc.



- **Engineering Software Company**
- **Provide Engineering Software and Services**
- **Since 2009**
- **Office Location : Seoul, KOREA**



# PHX ModelCenter Provider

ModelCenter Integrate	ModelCenter Explore	ModelCenter Organize
		

**ModelCenter Integrate**

- Model-Based Engineering Frameworks
- Integrate any simulation tool from any vendor
- Create and automate simulation workflows
- Set simulation parameters
- Seamlessly run multidisciplinary simulation processes

**ModelCenter Explore**

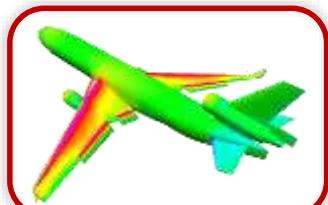
- Run powerful algorithms and trade study tools
- Search, investigate and understand the design space
- Incorporate multiple variables (cost, performance, risk)
- Visualize results and the impact of design changes
- Find optimum solutions

**ModelCenter Organize**

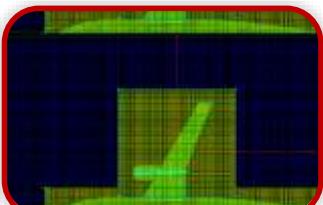
- Archive both data and meta-data used in and generated by model-based engineering applications
- Collaborate and share information with other team members and among stakeholder
- Establish and preserve the relationships between datasets to achieve traceability
- Reuse engineering data on future projects

# AMI(Analytical Methods, Inc.) CFD Solution Provider

## CFD Solver

**VSAERO**

Potential Flow Solver  
(Panel method)

**MGAERO**

Euler, Multi-Grid  
Transonic Flow Solver

**MSES/MISES**

Airfoil(external)/Cascade  
Blade(internal) Flow  
Analysis/Design

**CAMRAD II**

Planar Vortex-Lattice  
Solver for Aero &  
Stability Analysis

**NSAERO**

Navier-Stokes Flow  
Solver

**SDAERO**

Small Disturbance  
Potential Flow Method

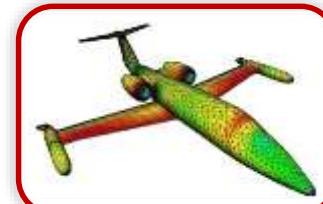
**USAERO**

Unsteady, Potential  
Flow Solver

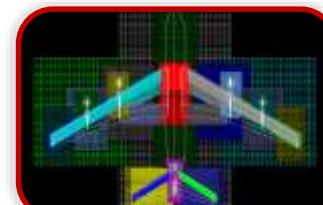
## Pre/Post

**OMNI3D**

3D Visualization Tool  
for Post-Processing  
of CFD Results

**SURFGEN**

Surface Grid  
Generation

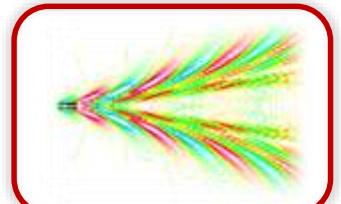
**PEP**

Panel Editing Program,  
Complement to SURFGEN

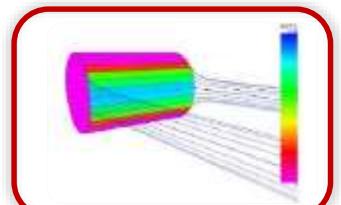
## Analysis Module

**FLIDYN**

Flight Dynamics Analysis  
with CFD Output

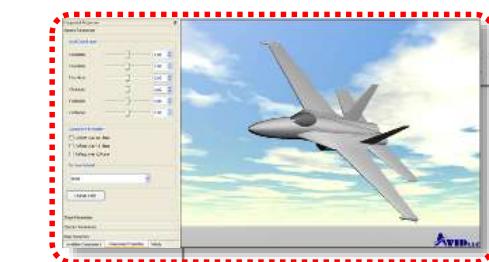
**FSWAVE**

Ship Free-Surface  
Wave Analysis  
Program

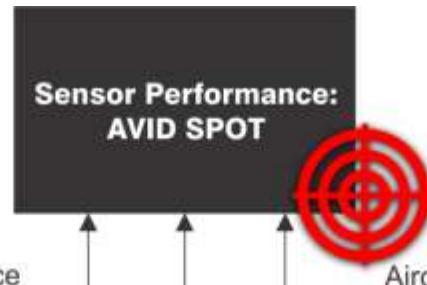
**ICE**

Icing & Water Droplet  
Trajectory Analysis

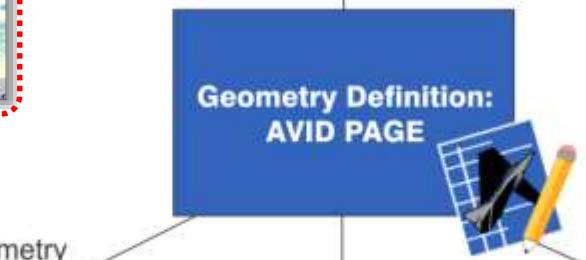
# AVID's Aircraft Design S/W Suite



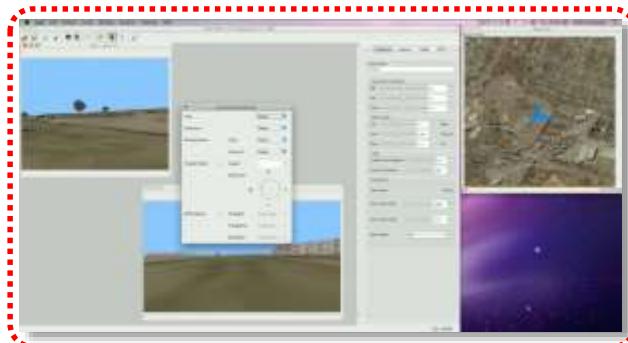
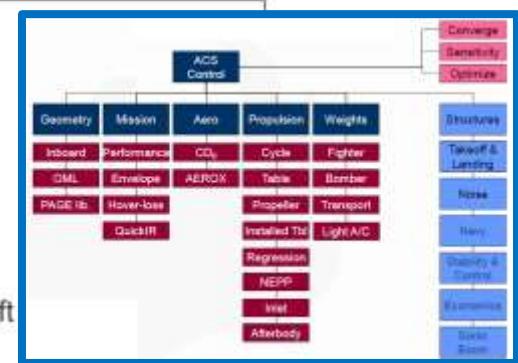
Performance



Aircraft Performance



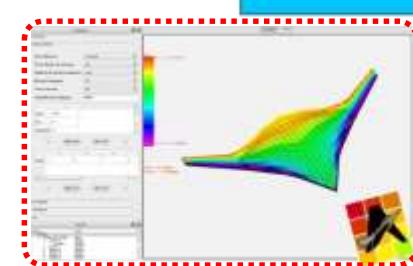
Aircraft Geometry



Ducted-Fan VTOL  
Aircraft Design and  
Performance Analysis:  
**AVID OAV**

Aerodynamic  
Corrections

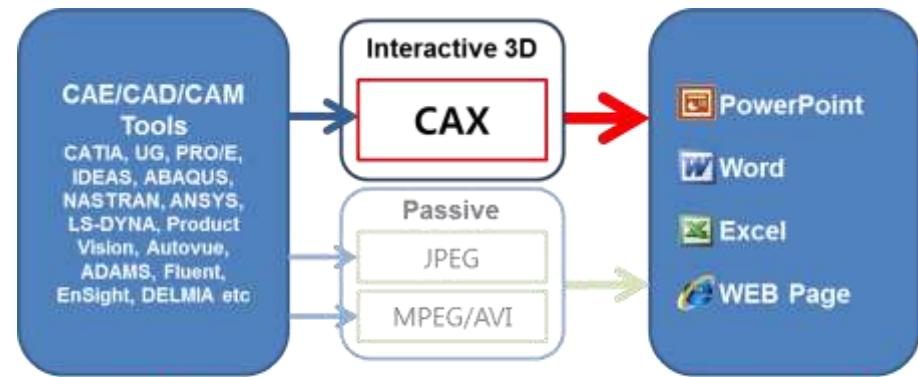
Aerodynamic Analysis:  
**AVID VorView**  
**AVID APEX**  
**AVID RAPT**

Aerodynamic  
Corrections

Fixed Wing Aircraft  
Design Optimiztion  
and Performance  
Analysis:  
**AVID ACS**



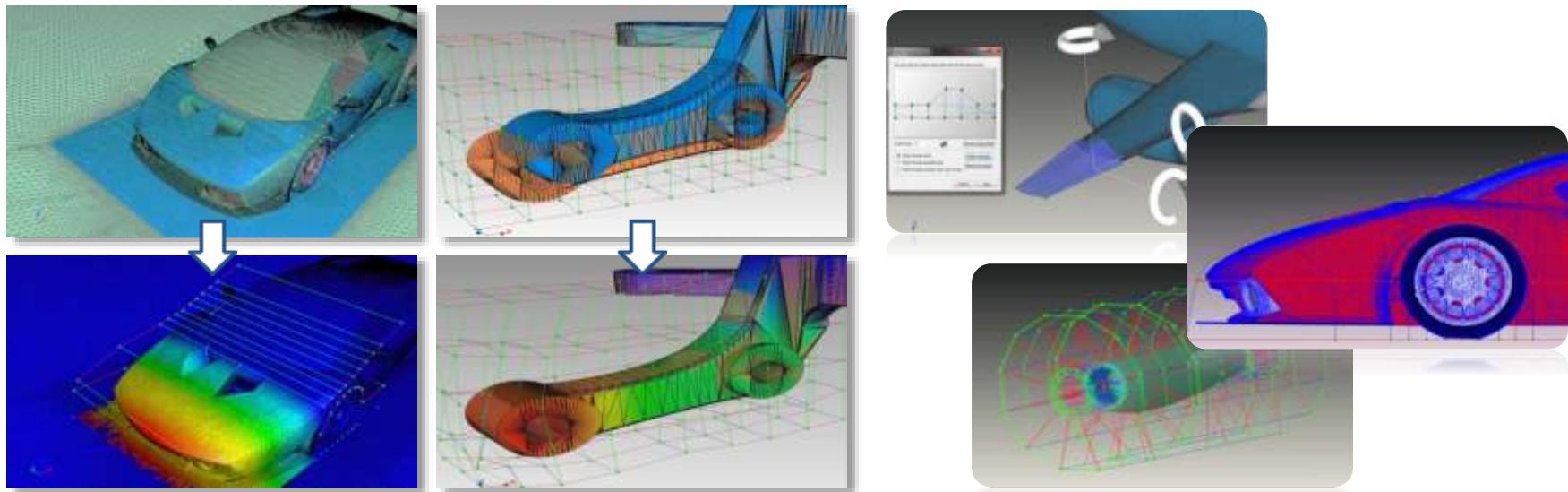
# Data Visualization & Collaboration Solution



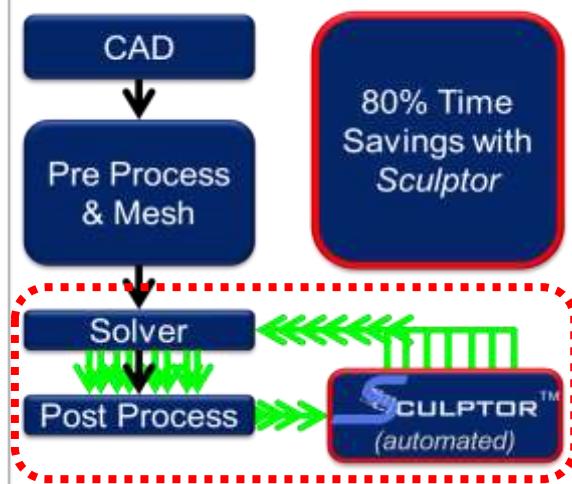
Interactive, Live, 3D Engineering Documents  
정확한 3D 정보로 보다 확실한 의사결정 가능

MS-PowerPoint	MS-Excel	MS-Word	Web Archiving	SDM (AnalysisLibrary)	CFD Results - Particle Traces, Streamlines	Cut Sections, Iso-Surfaces	CFD - External Flow Color Flooding	Vector Plots - Boundary Layers & Recirculation Region	Merged View (CFD(Fluent) + FEA(Nastran) + CAD(CATIA))	Probe CAE Data   Add Labels & Notes	Create & Save "View Point"	Create CAE Animation /Movies

# 3D Mesh Morphing for Shape Optimization

**S**CULPTOR™

## Optimization with Sculptor



Arbitrary Shape Deformation(ASD) 기술을 기반으로 STL/Point Cloud, CAD, CFD, FEA 포맷 데이터를 이용한 실시간 3D Mesh Morphing

### 쉽고 빠른 ASD Volume 생성

- Create Volume & Cylindrical Volume
- Volume Builder
- Shrink Wrap

PHX ModelCenter 등 최적화 솔루션과의 직접적인 연동이 가능한 Batch Mode 제공

# Getting Started

- Step-1 : 데모(평가판) 라이센스 발급
- Step-2 : 고객사 수행 과제 컨설팅/지원
- Step-3 : 개념입증(POC) 과제 수행

\* Contact : 로터스정보기술(주) 기술영업팀

[info@lotustech.co.kr](mailto:info@lotustech.co.kr) / [mskang@lotustech.co.kr](mailto:mskang@lotustech.co.kr)

(02) 543-3990~1





감사합니다.

- 로터스정보기술(주) 홈페이지 : <http://www.lotustech.co.kr>
- Phoenix Integration, Inc. 홈페이지 : <http://www.phoenix-int.com>
  
- 관련 제품문의  
Tel : (02) 543-3990 Fax : (02) 543-3992 E-mail : info@lotustech.co.kr