Phoenix Integration

- Provide engineering software and services to customers in aerospace, defense, and related industries

- 16 year history

- Evolved out of a research program at Virginia Tech

- Office locations
  - Philadelphia, PA (Corporate)
  - Blacksburg, VA (R&D)
  - California (Sales)
  - North East (Sales)
  - Toulouse, France

- World-wide sales in North America, Europe, and Asia

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OpenVSP Plug-In

The **OpenVSP Plug-In** allows engineers to quickly import an existing VSP model into the ModelCenter environment, expose key input and output parameters, automate VSP execution, and integrate the 3D geometry model with other analyses.
Phoenix Integration ModelCenter System Level Capabilities

1. **Integration**
   - “Open”, adaptable, vendor/tool agnostic environment for Hi/Lo fidelity models & simulations; for leading COTS, GOTS, internal
   - Distributed analysis over a network to access multi-disciplinary models as needed

2. **Visualization**
   - *Find Better Designs;* *Leverage for design review to get everyone on the same page*
   - Stakeholder-friendly views, Dashboards, Free Viewer, etc. to bridge communication gaps among technical and sponsor collaborators

3. **Automation**
   - “What if” analysis tools for better understanding of tradespace → cost reductions, improve quality..
   - 100s or 1000s more alternatives in same time vs. traditional methods
   - Design Exploration, Optimization,
   - Surrogate Modeling, Uncertainty/Reliability

4. **Model Based Systems Engineering (MBSE)**
   - Bi-directional modeling and requirements integration

5. **Data Management, HPC**

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Modeling and Simulation Tools
Vendor-Neutral Infrastructure that can integrate almost any code

### Product Design
- Given design parameters, predicts performance characteristics:
  - How much will it weigh?
  - How high can it fly?
  - What will it cost?
- Useful for designing hardware
- Wrap your code or use plug-ins:
  - Matlab
  - Mathcad
  - Excel
  - CAD
  - Abaqus
  - ANSYS

### Simulation
- Given performance characteristics, predicts how a system will react to various stimulus over time:
  - Hit rate?
  - Access times?
  - Throughput?
- Useful for designing systems
- Wrap your code or use plug-ins:
  - Flames
  - STK
  - OpNet
  - ProModel
  - Arena
  - Simulink
  - Extend
  - Vensim
Optimization Algorithms

- Nelder-Mead
- Hooke-Jeeves
- EVOLVE
- SwarmOps
  - Differential Evolution method
  - Differential Evolution method with dithered parameters
  - Self adaptive Differential Evolution method
  - Local Unimodal Sampling method
  - Many Optimizing Liaisons method
  - Pattern Search method
  - Particle Swarm Optimization method
  - Random sampling method
- DOT
  - Broydon-Fletcher-Goldfarb-Shanno (BFGS) variable metric method
  - Fletcher-Reeves (F.R.) conjugate gradient method
  - Modified Method of Feasible Directions (MMFD)
  - Sequential Linear Programming (SLP)
  - Sequential Quadratic Programming (SQP)
- BIGDOT
  - Sequential Unconstrained Minimization Technique (SUMT)
- DAKOTA
  - Asynchronous Parallel Pattern Search
  - Coliny COBYLA
  - Coliny DIRECT
  - Coliny Evolutionary Algorithm
  - Coliny Pattern Search
  - Coliny Solis-Wets
  - CONMIN methods
  - Multi-objective Genetic Algorithm (MOGA)
  - NCSU DIRECT
  - OPT++ Polak-Ribiere conjugant gradient
  - OPT++ Finite differences Newton
  - OPT++ Full Newton
  - OPT++ Parallel direct search
  - OPT++ Quasi Newton
  - Single-objective Genetic Algorithm (SOGA)
- Boeing
  - Design Explorer
  - SQP Gradient Optimizer
- Darwin
- NSGA II

The new architecture makes it very easy to add additional algorithms
## Probabilistic Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORM – First Order Reliability Method</td>
<td>Most Probable Point based</td>
<td>An efficient method which uses first order approximation of response function thus will be less accurate for highly non linear functions.</td>
</tr>
<tr>
<td>MV – Mean Value</td>
<td>Most Probable Point based</td>
<td>Most efficient and basic method not very accurate generally, used to get a feel of the response function.</td>
</tr>
<tr>
<td>AMV+ - Advanced Mean Value with Iterations</td>
<td>Most Probable Point based</td>
<td>More accurate than MV method and tries to converge on MPP. Efficient and highly accurate results if convergence is obtained.</td>
</tr>
<tr>
<td>EGRA – Efficient Global Reliability Analysis</td>
<td>Surrogate based/Sampling</td>
<td>A very accurate and highly efficient method which does sampling on Gaussian Process model of response function. Highly accurate for low probability and low variable cases.</td>
</tr>
<tr>
<td>Monte Carlo</td>
<td>Sampling</td>
<td>This method should be used to supplement other efficient methods to gain experience and confidence in those efficient methods. Provides good results always but at the cost of very high number of model evaluations, sometimes up to a million.</td>
</tr>
</tbody>
</table>
The OpenVSP Plug-In

- OpenVSP provides geometry in a larger design context
  - Quick and easy manipulation of geometric parameters, access to calculated values, as well as geometry definition files is critical in the design process
- Integration of OpenVSP as a plug-in is a no-brainer
  - ModelCenter and Analysis Server provide the MDO framework as well as the design exploration tools
  - OpenVSP provides the rich parameterized geometry
What does the OpenVSP Plug-in do?

- The OpenVSP Plug-in meets four specific goals:
  - Expose OpenVSP parameters in ModelCenter
  - Expose calculated OpenVSP outputs in ModelCenter
  - Export geometry file such that it can be passed to other analyses within a ModelCenter framework
  - Display the OpenVSP geometry
OpenVSP Plug-in Demo
Current status

- The OpenVSP plug-in is currently in beta

- Contact me if you would like to obtain a copy of OpenVSP, as well as ModelCenter and Analysis Server
  - We also have a hands-on tutorial session this afternoon
  - Analysis Server license file for today …

- We have received valuable feedback from users since the beta was released
  - That feedback is being addressed in the next release of the plug-in
  - We are also making incremental bug-fix and small upgrades to the current beta version
What’s Next?

- Under the hood:
  - OpenVSP is currently being restructured
    - Will provide the plug-in with better access to OpenVSP functionality
  - Better exception handling

- Additional features currently planned for:
  - Easier access and manipulation to OpenVSP parameters
    - Find and use the parameters you need without having to hunt for it
    - Hybrid variable selection (parameter can either be input or output)
    - Variable selection and manipulation for CFD and FEA meshing
  - Greater access to OpenVSP functions
    - Add or remove components
    - It will be possible to create OpenVSP geometry within ModelCenter
  - Concurrent geometry access and manipulation
    - Users will be able to view and work inside VSP as opened in ModelCenter through the plug-in
Questions?

- To get a copy of the plug-in, contact Andy Ko:
  - Email: ako@phoenix-int.com,
  - Phone: (540)961-7215 x302
**Set Targets**

- COST
- PERFORMANCE
- WEIGHT

**Model Based Systems Engineering (SysML) Tools**

**Confirm Targets**

- COST
- PERFORMANCE
- WEIGHT

**ModelCenter**

- Simulation Based Trade Studies & DOE’s

**ModelCenter**

- Model Based Systems Engineering

**ModelCenter**

- Engineering & Analysis Optimization

**System**

- COST
- PERFORMANCE
- WEIGHT

**Subsystem**

- BETTER
- FASTER
- CHEAPER

**Component**

**PHX Simulation Driven Design**

- Publish to: Enterprise Systems

**Analysis Server & Analysis Library**

**Resource & Information Capture and Sharing**

**Reliability Improvement**

**ModelCenter**

- Verification & Validation

**ModelCenter**

- Reliability Improvement

**ModelCenter**

- Resource & Information Capture and Sharing

**Analysis Server & Analysis Library**

**ModelCenter**

- Reliability Improvement
ModelCenter

1. Integrate
Wrap simulation/system/mission tools, databases and tasks into repeatable actions:

2. Automate (DOE, Optimization)
Flexible methods and wizards walk users through ideal selections for best results.

3. Visualize and Find Better Designs
ModelCenter Interface

- **Analysis View**: Displays wrapped codes as boxes
- **Component Tree**: Displays variables
- **Link Editor View**: Displays links between components
- **Server Browser**: Browses components wrapped on Analysis Servers
Integrating Your Models

Wrapping Language (Quick Wrap)
- Specify file parsing for input and output file
- No need for source code or input modification
- Automatically creates variables for Analysis Server

Other Scripting Options
- Write Java or C++ script to perform system commands or API calls
- Use Perl and create your own wrapping language to parse detailed files
- Create model in Excel and integrate through Visual Basic

Use Drag and Drop Plug-ins
- Matlab, Excel, Nastran, Ansys, CAD, etc…

If your simulation reads and writes files or has an API, we can wrap it!

Vendor neutral infrastructure that can integrate almost any analysis tool
Trade Studies

1. Build Automated Workflows
2. Execute Multiple Runs
3. Evaluate Trade-Offs

Parametric Study
Sensitivity Analysis
Design of Experiments
Optimization
Monte Carlo
The Algorithm Selection Wizard steps the user through multiple questions and recommends appropriate algorithms.
Each optimization algorithm has been benchmarked against a set of test problems. By matching your problem to problems in the test suite you can determine which algorithms are best for you.
Visualize and Interpret Results

Each point represents a design alternative with unique characteristics.

- GEN 1
- GEN 30
- GEN 80
- GEN100
Visualize, Compare, Share

Modify Requirements

Start/Stop Genetic Algorithm

Share Results w/ interactive free viewer/DataExplorer
Sensitivity Summary

Results from the 200 run DOE sensitivity study reported the top 12 variables that impacted results.
Probabilistic Method Selection Wizard

The Method Selection Wizard steps the user through multiple questions and recommends appropriate methods.
Selecting a Probabilistic Method

The Method Selection Wizard creates a ranked list of methods.

Details can be expanded to show individual criteria. Additional help is also available to understand how each algorithm works.
Results: Sensitivity Levels

Sensitivity levels show how the value of each design variable affects the reliability/probability of failure for each individual response. Thus providing means to control probability of failure.
Results: Importance Levels

Importance levels show the relative impact of each design variable.
What the Nessus Algorithms Mean To You…

If your simulation runs in 1 second and you want to predict a 1 in 1,000 failure (3 sigma)

- Monte Carlo requires 400,000 runs
  - 4.6 days

- Advanced methods can compute the same result in 200-400 runs
  - 6.7 minutes
PHX AnalysisLibrary

• Capture Project and Design Evolution
  • Focus on ease of use and accessibility
  • Manages work-in-progress and legacy data
  • Replace shared drives & desktop folders
  • Collaborate with all shareholders
  • Provides folder prescription & security

• Features
  • File/Folders with metadata
  • Web and desktop access
  • Detailed searches
  • Version control
  • Change notification
  • Automatic file indexers
  • File compression *
  • Automatic publishing *
  • Easy deployment

* Optional with VCollab Integration
Product Family

ModelCenter
- Simulation workflow
- Trade Studies
- Decision Support

VisualizationPak

OptimizationPak

CAD/CAEFusionPak

ReliabilityPak

AnalysisLibrary
- Shared-Drive Replacement

Analysis Server
- Light-weight wrapper hosting and execution
- SOA Architecture
- Parallel Processing
- Web Browser Access

CenterLink

Compute Cluster

Files with XML metadata
- Search
- Version Control

Change Notification
- Web Access
- Drag and Drop GUI