

NSRP Improved Methods for the Generation of Full-Ship Simulation/Analysis Models 2 NGSB – GC Efforts

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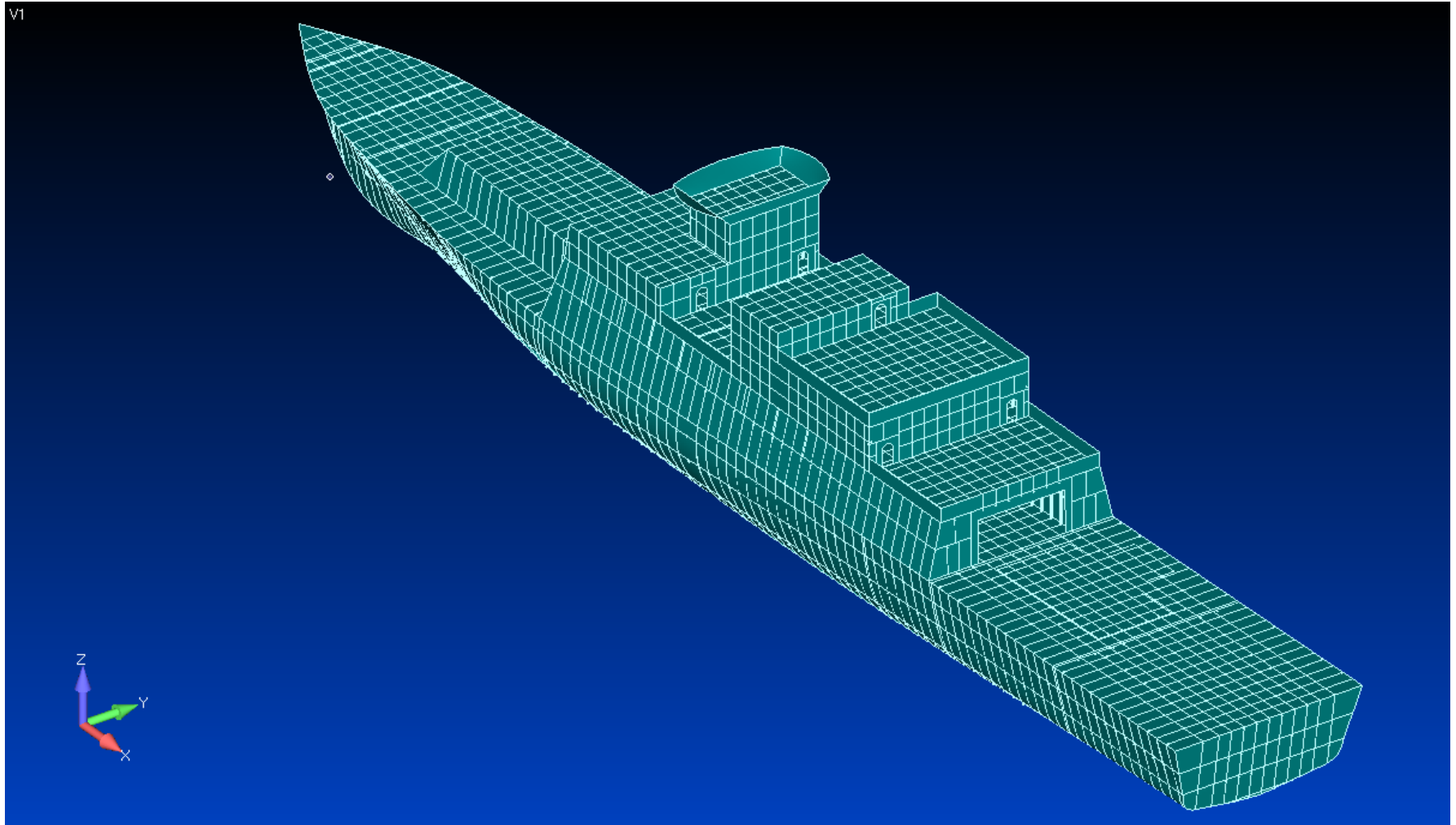
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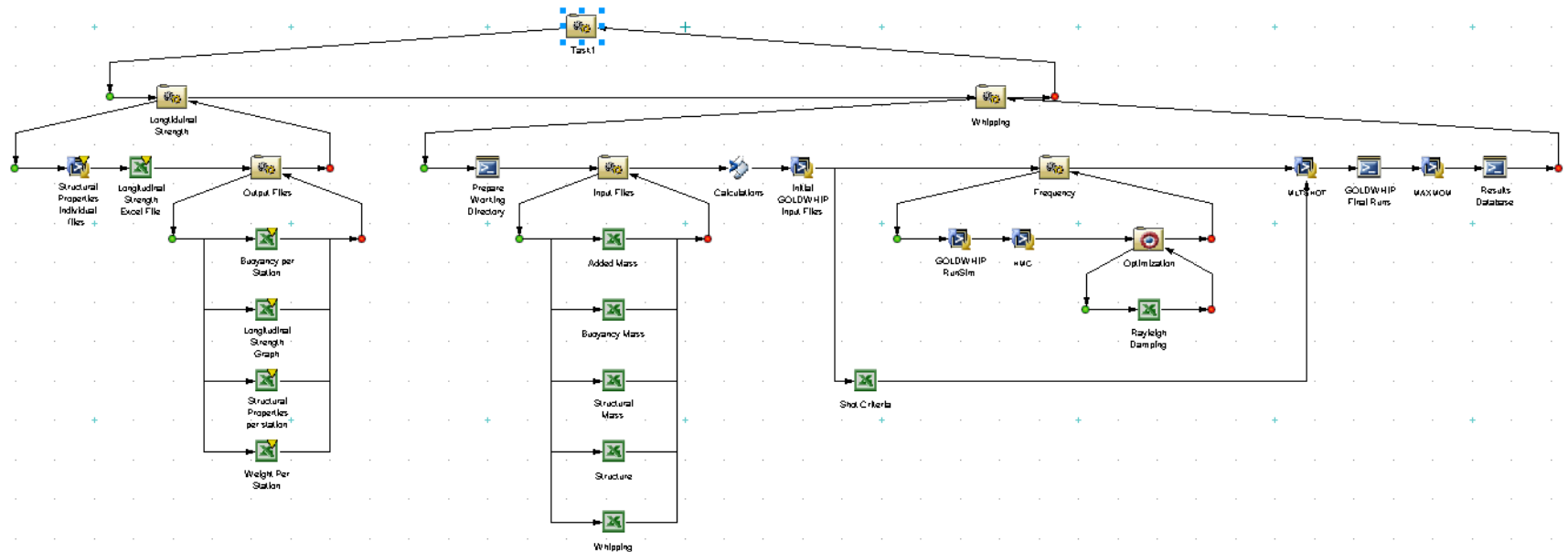


- Since 2007, a team of shipbuilders and software vendors have been conducting two **National Shipbuilding Research Program (NSRP)** projects entitled *Improved Methods for the Generation of Full-Ship Simulation/Analysis Models 1 & 2 (M&S)*
- The objective of the two projects was to reduce the cycle time required to develop large scale full ship analysis models for strength, stress, shock, and acoustic simulations and assessment
- The team consists of:
 - General Dynamics/Electric Boat Corporation (EB)
 - Northrop Grumman Shipbuilding, Inc. (NGSB)
 - TechnoSoft Inc (TSI)
 - Dassault Systèmes Simulia Corporation
 - Product Data Services Corp. (PDSC)

First Type of Full-Ship Simulation/Analysis Model

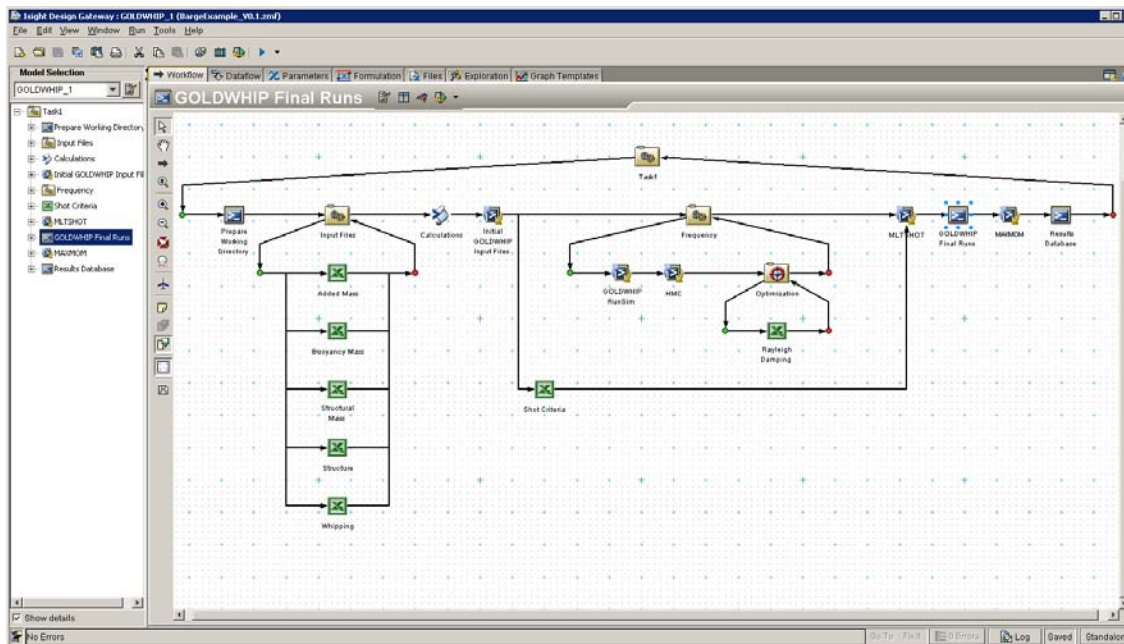


Second Type of Full-Ship Simulation/Analysis Model



SIMULIA Isight Tool Utilized

- **Isight** is a desktop solution that provides a suite of visual and flexible tools for creating simulation process flows—consisting of a variety of applications, including commercial CAD/CAE software, internally developed programs, and Excel spreadsheets—in order to automate the exploration of design alternatives and identification of optimal performance parameters



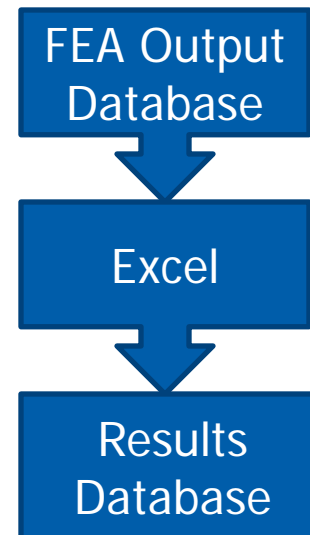
- NGSB-GC emphasized improvement of modeling processes in legacy systems in the M&S 2, Phase 1 project
- Isight
 - Beam Model Development and Analysis
 - Whipping Analysis
 - Longitudinal Strength Analysis
 - Post Analysis Processing

Expansion of Isight Experience in M&S 2, Phase 2 Project

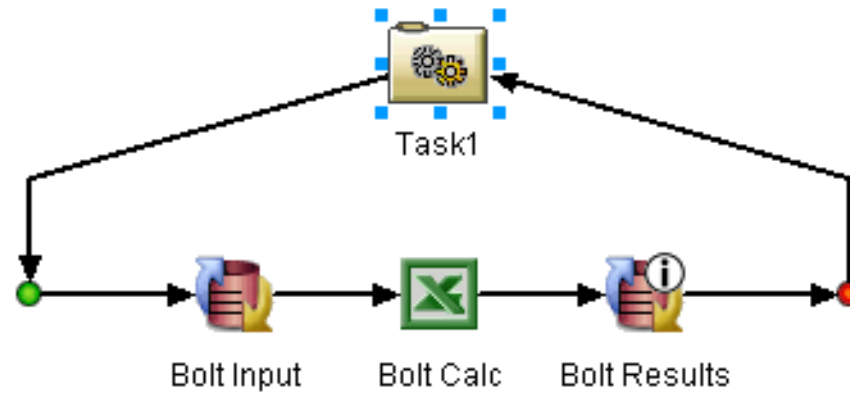
- Using our previous experience with Naval Architecture, and Shock and Vibration Analysis Simflows, NGSB-GC looked to expand into other technical areas:
 - Structural Analysis
 - Weight Control
 - Marine Technical
 - Field Engineering
- A series of 8 simulation data flows (Simflows) were proposed to be developed and evaluated during this phase of the project:
 - Bolt Calculation (Structural Analysis)
 - Foundation Analysis (Structural Analysis)
 - UERD Tools (Shock and Vibration)
 - Shipweight (Weight Control)
 - Pipe Hanger Support (Marine Technical/Shock and Vibration/Field Engineering)
 - Rafting Foundation (Structural Analysis)
 - Linearized Stress (Marine Technical/Shock and Vibration)
 - Optimized Linearized Stress (Marine Technical/Shock and Vibration)

Bolt Calculation Simflow

- This simflow is Structural Analysis Legacy Process
- The objective of this simflow is to calculate the stress levels in the bolts of equipment based on the loading from the foundation analysis
- This simflow will eventually be a sub task of the overall Foundation Analysis Simflow



Bolt Calculation Simflow



Bolt Calculation Simflow

The screenshot displays the Bolt Calculation Simflow software interface. At the top, a menu bar includes options for Sim-flow, Dataflow, Parameters, Formulation, Files, Exploration, and Graph Templates. The main window is titled "Bolt Calc" and features two tabs: Overview and Mappings. The Mappings tab is active, showing a central workspace with two parameter trees connected by mapping lines.

Left Tree (Bolt Calc):

- Bolt Size Index
- Bolt Yield Strength
- Bolts on X Side
- Bolts on Y Side
- Effective Bolts
- Equipment Weight
- Fore-Aft Acceleration
- Length CG
- Length X
- Length Y
- Orientation
- Transverse Acceleration
- Vertical Acceleration
- workbooks
 - Longitudinal Normal
 - Longitudinal Normal Check
 - Longitudinal Shear
 - Longitudinal Shear Check
 - Longitudinal VM Check
 - Longitudinal Von Mises
 - Transverse Normal
 - Transverse Normal Check
 - Transverse Shear
 - Transverse Shear Check
 - Transverse VM Check
 - Transverse Von Mises
 - Vertical Normal
 - Vertical Normal Check
 - Vertical Shear
 - Vertical Shear Check
 - Vertical VM Check
 - Vertical Von Mises

Right Tree (Bolt Input):

- Bolt Input
 - Boltdata_txt
 - Bolts per X side
 - Bolts per Y side
 - CG
 - Effective Bolts
 - Equipment Weight
 - Index
 - Length X
 - Length Y
 - Longitudinal Shock Factor
 - Orientation
 - Transverse Shock Factor
 - Vertical Shock Factor
 - Yield Strength

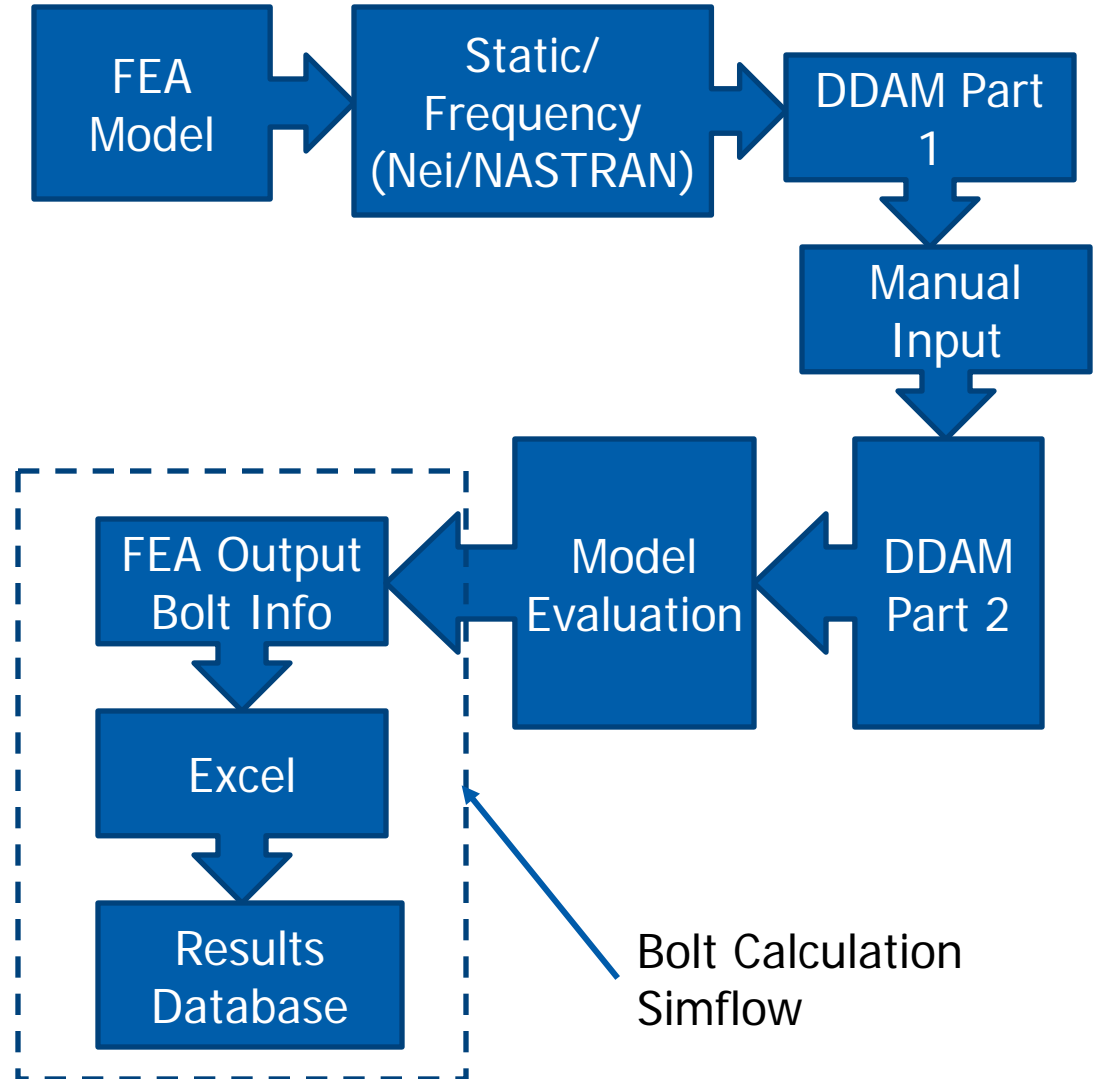
Right Tree (Bolt Results):

- Bolt Results
 - Boltresults_txtTpl
 - Boltresults_txtTpl2
 - Longitudinal Normal
 - Longitudinal Normal Check
 - Longitudinal Shear
 - Longitudinal Shear Check
 - Longitudinal Von Mises
 - Longitudinal Von Mises Check
 - Transverse Normal
 - Transverse Normal Check
 - Transverse Shear
 - Transverse Shear Check
 - Transverse Von Mises
 - Transverse Von Mises Check
 - Vertical Normal
 - Vertical Normal Check
 - Vertical Shear
 - Vertical Shear Check
 - Vertical Von Mises
 - Vertical Von Mises Check

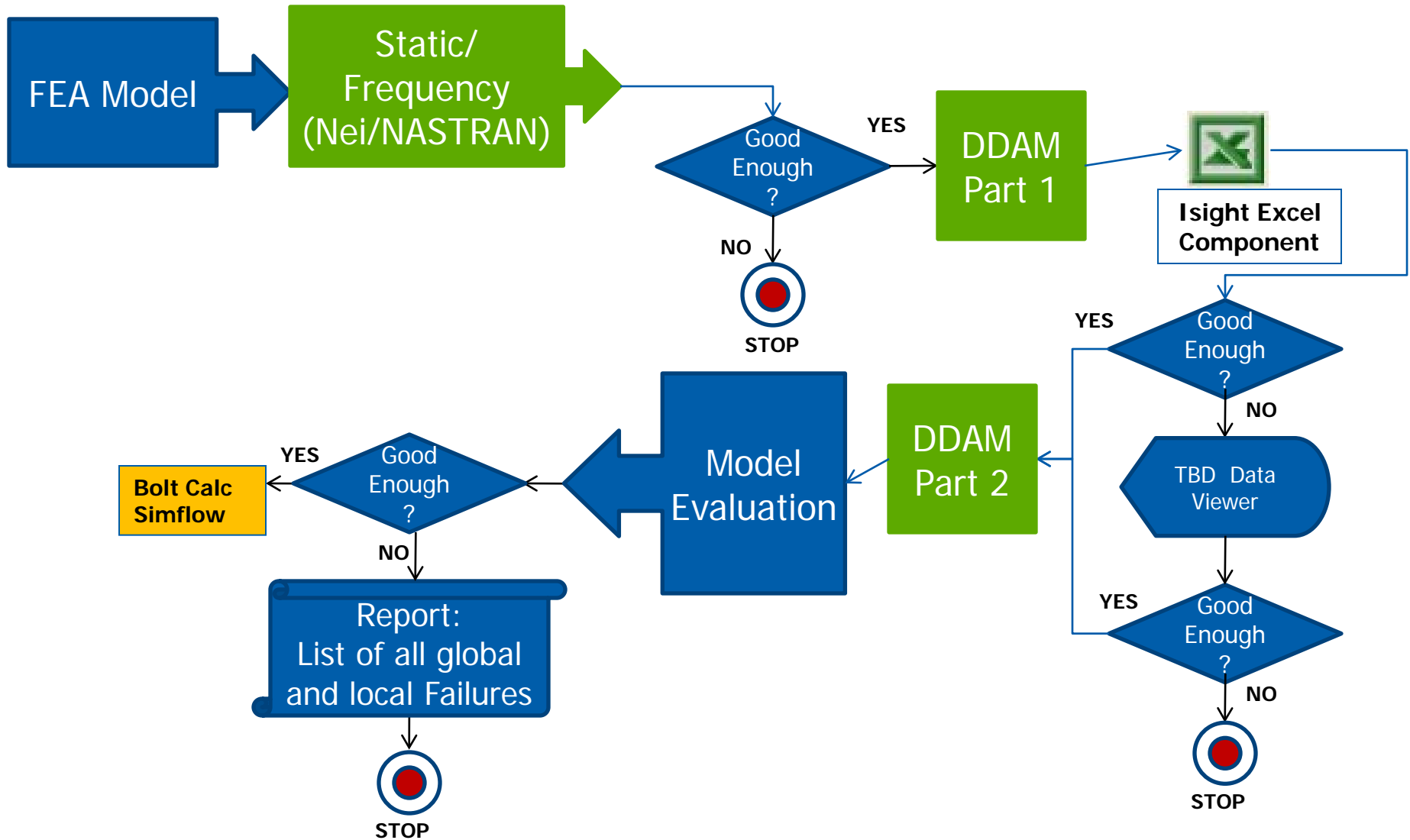
Yellow arrows indicate mappings from the Bolt Input tree to the Bolt Calc tree. Blue arrows indicate mappings from the Bolt Calc tree to the Bolt Results tree. At the bottom, there are two "Selected Parameter" fields, each with a "Type" dropdown set to "Real" and a "Value" input field.

Foundation Analysis Simflow

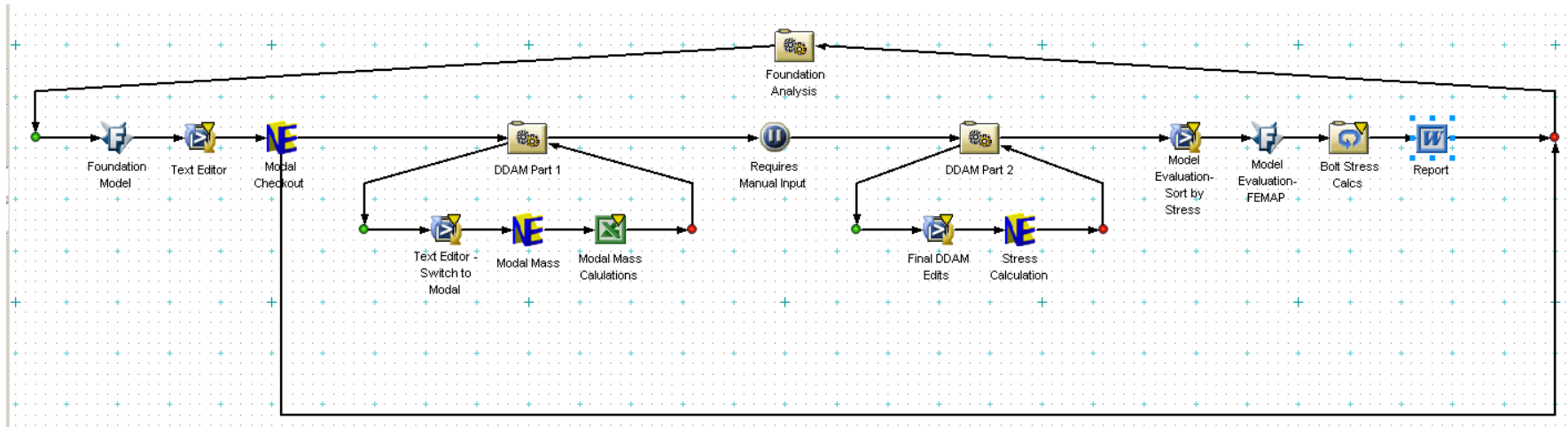
- This is a Structural Analysis Legacy Process
- The objective of the simflow is to streamline the foundation analysis process based on an existing FEA foundation model
- This simflow is the most advanced simflow we have worked on. It requires multiple evaluations and multiple analysis runs.



Foundation Analysis: Initial Simflow Design

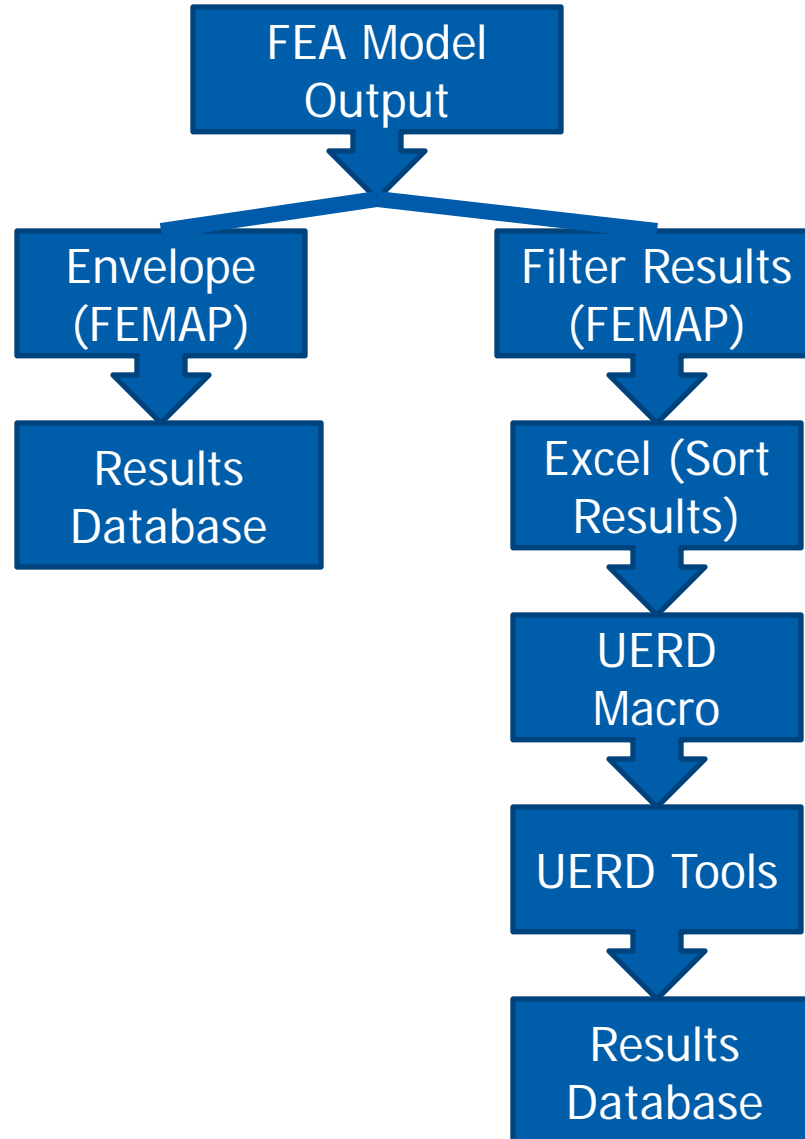


Foundation Analysis Simflow: Initial Model



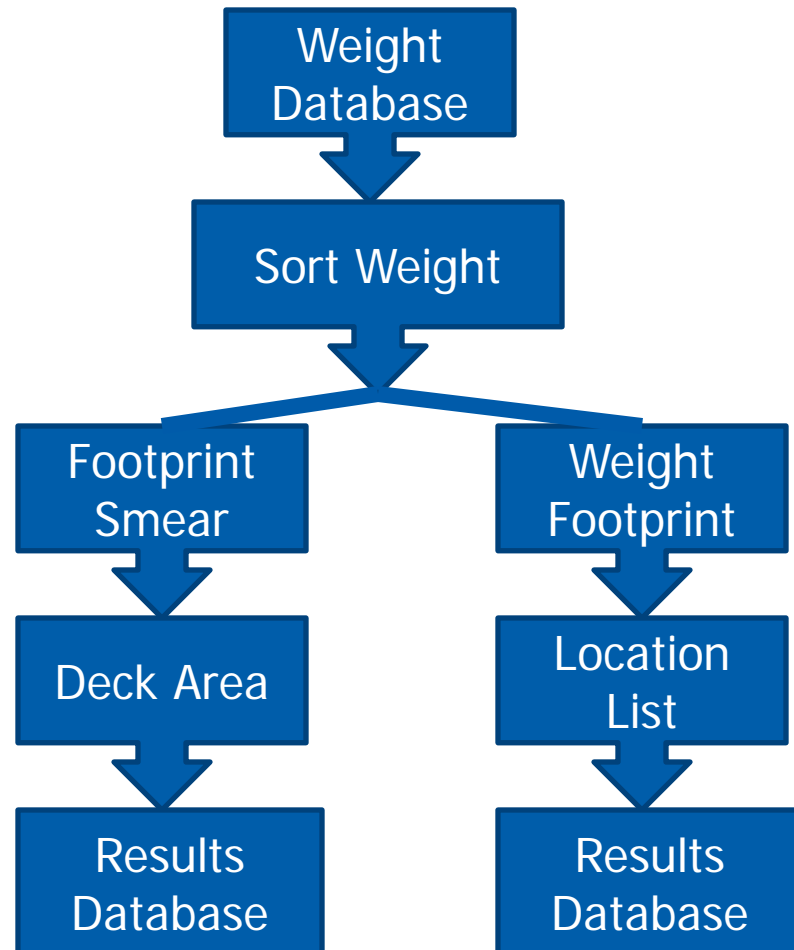
Results Evaluation with UERD Tools Simflow

- This is a Shock and Vibration Analysis legacy process
- The objective of this process is to streamline the post processing effort of a transient analysis model and results



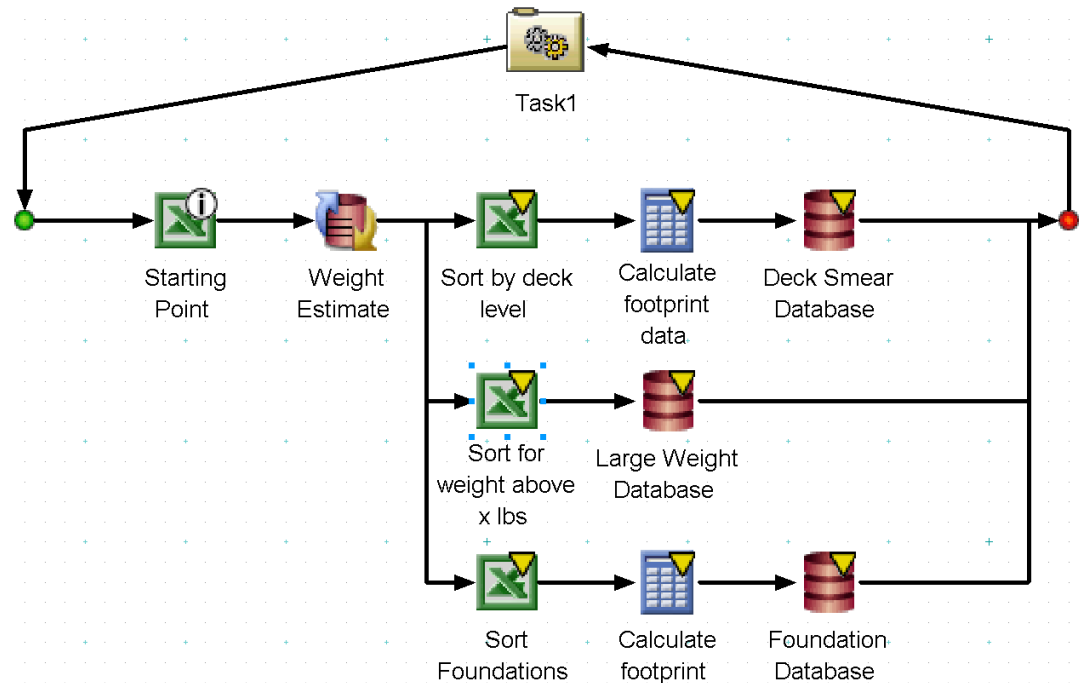
Full Shipweight Simflow

- This is a Weight Control legacy process
- The objective of this Simflow is to streamline the manipulation of the Ship Weight Database for Naval Architecture, Structural, and Shock and Vibration Analyses



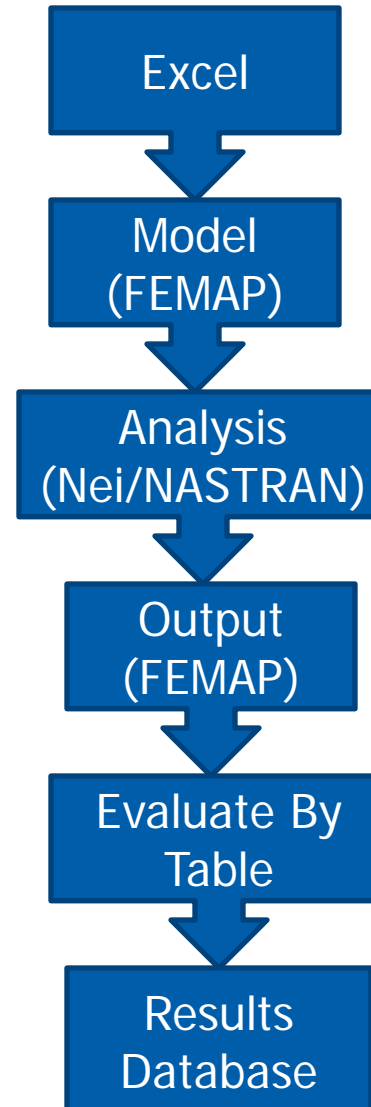
Full Shipweight Analysis: Initial Model

- Excel component, **Starting Point**, reads an Excel worksheet which contains deck level and SWBS specifications
- Data exchanger component reads in tab delimited file, **Weight Estimate.txt**, into a dynamic array. The text file contains ship element descriptions location and weight data.
- The dynamic array is processed in three ways:
 - The **Sort by deck level** path locates all ship elements that are not foundations and calculates the ship element footprint, and creates the **Deck Smear database**.
 - The **Sort for weight above x lbs** path locates all large ship weights and then creates the **Large Weight database**.
 - The **Sort Foundations** path locates all ship elements that are foundations calculates the ship element footprint, and creates the **Foundation database**.



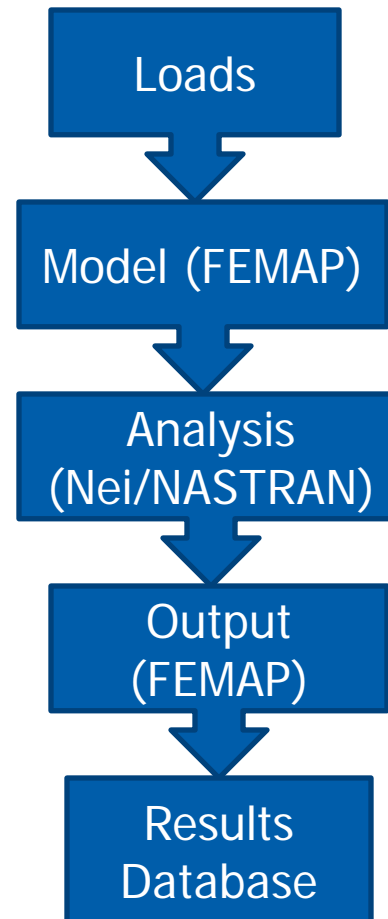
Pipe Hanger Support Structure Simflow

- This is a Marine Technical, Shock and Vibration analysis, and Field Engineering legacy Process
- The objective of this Simflow is to evaluate the need for support structure for Pipe Hangers based on weight and location



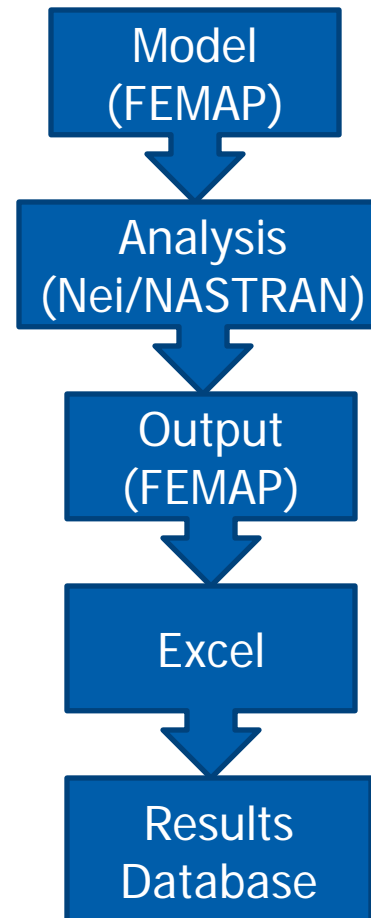
Rafting Foundation Simflow

- This is a Structural Analysis legacy process
- The objective of this simflow is to calculate the required support structure for a raft or isolated foundation



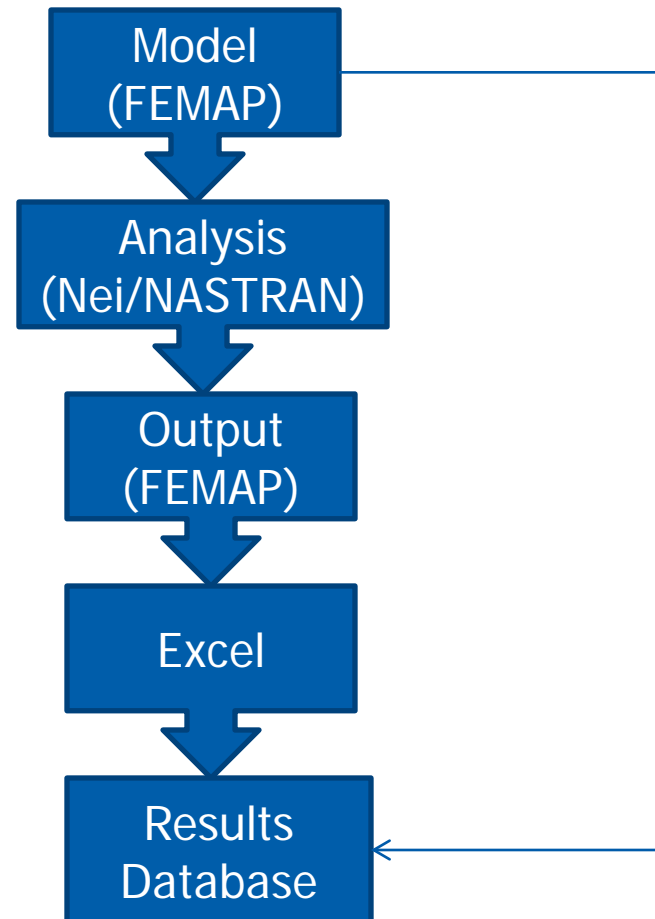
Linearized Stress Analysis Simflow

- This is a Marine Technical and Shock and Vibration legacy process
- The objective of this simflow is to evaluate the fatigue capability of a piping system component



Optimized Linearized Stress Analysis Simflow

- This is a Marine Technical and Shock and Vibration legacy process
- The objective of this simflow is to evaluate the fatigue capability of a piping system component
- The Statistical Evaluation will evaluate actual variations of the pipe systems to determine the bounds of the fatigue analysis
- This simflow can be set up for advance modeling by using multiple variable models



- NGSB-GC is leveraging previous experience with Isight to evaluate the tool's usage in other technical areas of shipbuilding
- The presented series of 8 potential NGSB-GC simflows is expanding into these other technical areas:
 - Structural Analysis
 - Weight Control
 - Marine Technical
 - Field Engineering
- As previously shown, Isight improves the users' capabilities to meet analysis requirements with its flexibility in areas such as:
 - Flexibility to incorporate multiple applications into one process flow
 - Automatically reading input files in Isight vs. manually transferring data into applicable data formats
 - Increases capability of configuration management and collection and storage of data
 - Removes the opportunity to make manual data errors
 - Processes documented in Isight give the added benefits of a good communication and training device for process owners

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