

## Analytical Modeling 'Pinpoints' the Cause(s)

Altran Solutions' engineers use computational tools to help model the complex behavior of solids and fluids in various engineering applications and accident investigations. These analytical tools (e.g., Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD) including thermal hydraulics and waterhammer) are used to:

- Analyze failures
- Evaluate new designs or modifications
- Solve fluid flow or heat transfer problems
- Evaluate degraded conditions

For instance, to address an excessive vibration problem of the main steam piping at a nuclear plant, Altran Solutions created an acoustic model based on the governing differential equations of steady oscillatory flow. This model was used in a frequency response analysis to determine pressure and flows at selected locations as a function of frequency. These were compared to pressure and acceleration data obtained in the site. The study enabled the nuclear plant to quickly identify the source of the excitation—a flow distribution header—from six potential suspects. By not doing this, the alternative would have been a long and costly trial-and-error process where each of the six potential sources would have been modified. The modeling technique used was also proven to be effective in identifying a permanent fix for the excessive vibration.

### Problem Definition and Solution

Before we begin the process, Altran Solutions works closely with its clients in defining the problem and the questions that need to be answered. We explain to the client the range of computational tools available and the pros and cons of each. Following the selection of the proper computational technique, we use a defined process to help guide us to the solution. For example:

- Generation of the model including geometry, mechanical properties, boundary conditions, loading conditions, and load combinations.
- Debugging, executing the solution, and obtaining results.
- Post processing and interpretation of results.
- Evaluation against the acceptance criteria.

It is essential that the analyst fully understands the fundamentals and physics of the problem and be able to assess the quality of the results at hand. **To avoid common pitfalls, clients need to be aware that no software package provides the "quality solution" to any problem without the added value of an experienced and knowledgeable analyst.**

Some of the most common pitfalls among less experienced analysts are:

1. The modeling does not correctly represent the physical phenomena.
2. Finite element types used are not the best suited for the application.
3. Solution options used are not the most appropriate.
4. Solution obtained is mesh dependent.

Such pitfalls can adversely affect the results and the conclusions.

### Result Interpretation

Another important aspect to computational modeling is the interpretation of results and the reconciliation with applicable codes and specifications. At Altran Solutions, our analysts are knowledgeable of the intent of the acceptance criteria. We use post processing tools available in computation programs to obtain results that are consistent with the intent of the criteria at hand. In this regard, it is essential to be able to characterize the finite element stresses properly into membrane, bending, shear, and bearing stresses and into peak, general, or discontinuity stresses. This classification of the analysis results is essential to correctly reconcile the analyzed components without undue conservatism.

Altran Solutions' engineers have extensive experience in application of finite element methods to wide varieties of complex problems not only for code qualification but also for failure analysis and accident investigation. **We apply finite element methods to analyze pressure vessels, nozzles, fittings, valve components, structural components, and biomedical devices.** We have modeled fuel canister drop using elasto-plastic behavior and large deformation material models. We have also leveraged our laboratory capabilities to benchmark finite element models before the product actually goes into production. This provides clients with substantial

cost savings and less risk especially if the product goes into production without any real analytical assessment. It also eliminates the need for extensive testing in the areas of mechanics, materials, performance, etc.

In the computational fluid dynamic (CFD) area, we have assisted clients with:

- Estimating flow and temperature patterns throughout steam tunnels.
- Transformer vaults under natural convection and forced convection.
- In flow disturbances through butterfly valves and estimated the flow torque acting on the disc.
- Single phase and multi-phase flow simulations to obtain flow characteristics in piping system in the power industry. ~ Simulation of waterhammer.
- 

Altran Solution's solid knowledge in the areas of thermal hydraulic principals is essential in applications of CFD in order to prepare models that are representative of the situation and to successfully interpret the results.

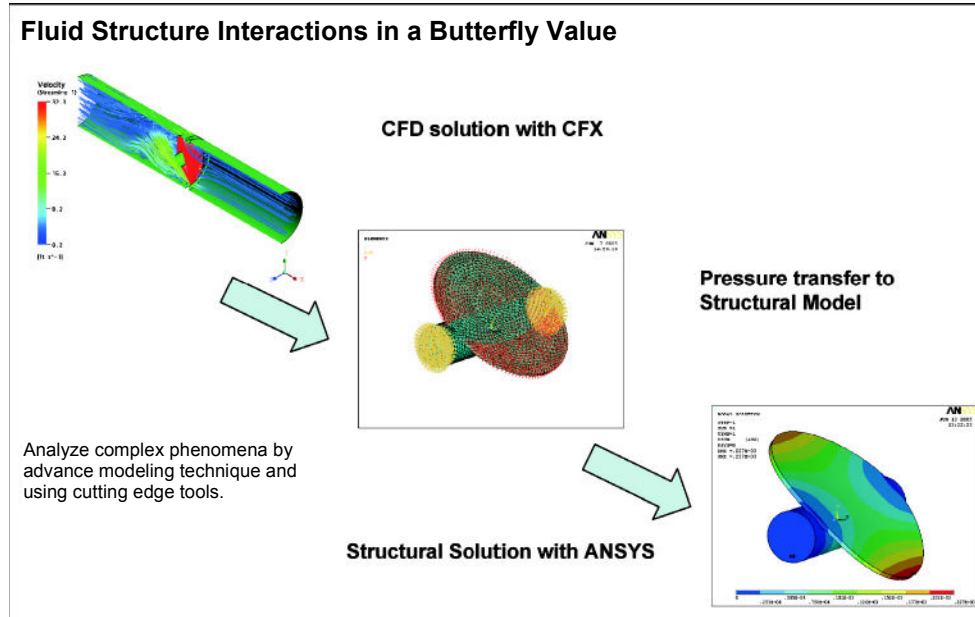
### Why Companies Need to Use Analytical Modeling?

Analytical modeling is a valuable tool to use in your next engineering application or accident investigation.

#### Benefits:

- It is a good viable alternative to difficult, expensive, and time consuming laboratory or full scale testing.
- Computational methods can be easily employed to test the performance and functionality in the product development stage.
- Computational methods are used to recreate accident and failure scenarios.
- With the availability of low cost high speed electronic computing, large size problems with complex material behavior and boundary conditions lend themselves to relatively easy solutions.

Altran Solutions has a proven track record in combining laboratory capabilities with numerical simulations for benchmarking purposes while delivering highly reliable computation simulations.



### Modeling Capabilities

- Thermodynamic analysis
- Heat transfer
- Fluid flow including two phase transients
- Waterhammer—method of characteristics
- Steady oscillatory flow-impedance method
- Transfer matrix method
- Fluid load Characterization
- Vortex shedding

**By using analytical modeling, Altran Solutions was able to save the client the cost of field or large scale laboratory testing and the great potential for failure in the field and downtime to come up with a fix.**

For more information on this capability, Please contact us at (617) 204-1000 or via e-mail at [sales@altransolutions.com](mailto:sales@altransolutions.com)