

Altair's Smart Multiphysics

CIMdata Commentary

Key takeaways:

- *As industry moves toward “up front” systems engineering, the use of optimization and probabilistic technologies will become increasingly important for choosing the “best” design to meet multi-domain system level performance requirements*
- *Altair's physics-based simulation solvers all have a multi-physics capability with embedded optimization capabilities, they may also be run together in a co-simulation if that is required to better capture detailed physics*
- *Access to increased computational resources via both desktop and mobile devices connected to scalable cloud and high-performance computing (HPC) solutions will make it practical for more engineers to leverage performance modeling and simulation tools throughout the product development lifecycle*

As physics-based simulation becomes faster and more capable, companies are using it earlier in the product development process to solve more complex problems. Altair has dubbed its integrated solutions offering *Smart Multiphysics*.

Each of Altair's flagship solvers, OptiStruct[®], RADIOSS[®], AcuSolve[®], and MotionSolve[®], is a multi-physics code in its own right. But, each may not always reflect the required combination of physics required for a specific problem. So, their solvers can also be coupled in a co-simulation mode to correctly capture the appropriate details. They define “Smart” as using the right technology to get the correct solution.

Altair's solvers also are designed to enable optimization as a natural element of simulation. For example, OptiStruct provides a framework for structural optimization, while HyperStudy enables workflows to link applications for design of experiments and other optimization studies, including in-house and third party algorithms. Thus, Altair's goal is to provide a comprehensive multiphysics capability within an integrated optimization capability.

The context for moving to multiphysics optimization is clarified by the systems engineering Vee process diagram, Figure 1. The left side of the Vee is product ideation, architecture, and concept selection. The right side comprises realization and validation of the physical product.

Traditionally, computer-aided engineering (CAE) has been used on the right side of the Vee as an analog of testing for performance evaluation and product validation. This function is extremely important, and is well-established at many companies.

Note that the base of the Vee is acquiring and designing components. This means that on the right of the Vee the component dimensions and interfaces have already been decided. There is little freedom to substantially change the design at this point in the process. Changes are very expensive, and optimization is not very effective because of the maturity of the design and design constraints that are already in place. “Optimization technology is being applied too late at this stage in the process,” says Uwe Schramm, Altair's Chief Technology Officer. To paraphrase an industry expert, Matthew Loew, “If you have CAD [computer-aided design geometry], it's too late.”

Optimization can be more gainfully applied on the left of the Vee, when the design is less formally defined and there is more freedom to conceptualize alternative concepts. But, the context is very different. In brief, during product architecture and concept selection, very

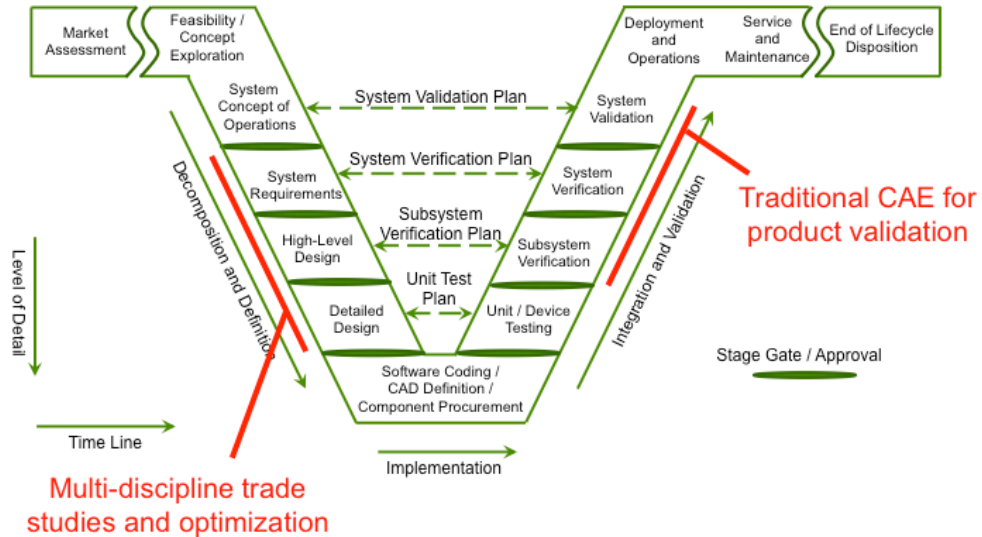


Figure 1 – The Systems Engineering Vee¹

complex decisions involving choices across domains (mechanical, electrical, software, controls, etc.) and physics disciplines (structures, fluids, thermal, optics, etc.) are being made. One must address these multi-dimensional systems engineering issues.

Altair's vision, shared by many industry thought leaders, is that the systems engineering trade studies and optimization should be done up front and in sufficient detail such that the right side of the Vee becomes a simple exercise in product realization, with little iterative development. In other words, simulation would be used to generate, rather than evaluate, product configurations, geometry, material selection, and the like. This is the need that "smart multiphysics" addresses.

Bob Yancey, Altair vice president for aerospace solutions, describes a typical use case. "Aircraft companies have simulation silos with sequential hand-offs," he says. "The loads on the aircraft are provided by the aerodynamicists after they determine the aircraft configuration. The aircraft structure is then designed, and the aerodynamic loads need to be reassessed because the structural stiffness and deflection of aerodynamic components is different than those used initially. This cycle can be repeated only twice or three times during an aircraft development program. If we can couple the aerodynamic and structural optimization in a single simulation, we enable 20 or even 50 iterative cycles, resulting in better products and shorter time-to-market."

Altair's Internal Innovation

Altair was founded in 1985, and soon rose to prominence with its CAE modeling application, HyperMesh[®]. OptiStruct was launched in 1994, starting the company on its trajectory to develop simulation solvers within an overarching optimization strategy.

The company was a pioneer of the idea that a comprehensive suite of software (HyperWorks) could provide additional value and utility, enabling all applications to be run using a pool of license tokens. An extension of functionality is provided via the [Altair Partner Alliance](#)², which

¹ Adapted from: US Federal Highway Administration: <http://ops.fhwa.dot.gov/publications/seitguide/> "Systems Engineering for Intelligent Transportation Systems"

² <http://www.altairalliance.com/>

gives customers token-based access to applications from select third-party developers, whose offerings run on the HyperWorks platform.

Altair has recently taken innovative access to CAE software and HPC resources to the next level by offering a range of cloud-based solutions. Users are able to run CAE simulations instantly on their desktops anywhere by leveraging Altair's Hosted HyperWorks Units (HHWU). For enterprise capabilities, customers can scale on premise (HyperWorks Unlimited™), or on the cloud (HyperWorks On-Demand), while simultaneously managing the entire simulation data lifecycle with Altair's Simulation Cloud Suite.

HyperWorks Unlimited is an innovative HPC appliance for CAE delivered as a turn-key system to the customer site. It comes fully configured with HPC hardware and Altair software, offering unlimited private cloud use of all Altair HyperWorks engineering applications.

Altair pays close attention to customer needs to drive customer value. In addition, the company offers engineering services, often fostering deep collaborations with customers to address technical challenges. This customer-centric approach drives innovation in Altair's simulation software offerings.

The Multiphysics Software Portfolio

Altair rightfully claims to be a leader in multiphysics simulation. The company now boasts a range of solvers for structures, fluids, mechanisms, composite materials, and electromagnetics, which will likely expand as customers' needs evolve. The offerings demonstrate leading-edge applications, such as the optimization of mechanisms like aircraft control surfaces in a multiphysics calculation that includes aerodynamic loads and structural deflections (flexible bodies).

Recommendations

CIMdata believes that the use of optimization coupled with increasingly comprehensive multiphysics and multi-domain simulation will revolutionize product development. Companies that exploit these technologies will gain a sustainable competitive advantage, developing better products in less time.

End-users should examine their development processes to target the use of optimization where it can be most beneficial. Usually, this is at a point early in the product development cycle, when CAE specialists are not typically engaged. A hierarchy of models should be used not only to evaluate performance, but to communicate design status and intent.

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