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Coupled Design and Analysis (CDA): Win the Race to Market

The race to drive down Time to Market has never been as fierce as it is in today's highly competitive, global, price sensitive markets. But paradoxically, constraints on resources have perhaps never been so tight. The design engineer is now being squeezed with triple duty: Superior products, faster turnaround, less resources. This is the "next reality".

Christine Lemyze, Vice President for Marketing, PLM Solutions at IBM recently wrote a commentary in *Desktop Engineering* about the transformation of manufacturing that has begun, and is rapidly gaining momentum. This transformation is being driven, in part, by the Best-in-Class processes enabled by PLM (Product Lifecycle Management). In her commentary, she cites that PLM is currently being used by less than 10% of Fortune 1000 companies, though some analysts, such as Gartner predict that companies that don't implement PLM by 2007 won't even be able to compete. This undoubtedly raised a few eyebrows. But it should have come as no surprise.

The new paradigm of Coupled Design and Analysis, referred to as "CDA", is a small component within PLM, buried a few layers into the onion, but its effect on the product development process is very substantial, and will impact the rate of penetration and growth of PLM solutions.

CDA is not entirely a new concept. A number of companies, including several major players in the CAD and CAE markets have been working on bringing the analysis increasingly closer to the early design stage, where CAD is the star player. Historically, analysis has typically been relegated to the R&D departments, or to the tail end of the design process as another affirmation of a design's viability, and certainly has added value in this manner. However, the earlier this "design affirmation" can be made, the greater leverage it has. Sound preliminary designs can provide dramatic improvements downstream, improving quality, reducing costs and scrap rates, but most importantly, decreasing that all-important Time-to-Market.

Thus, successful PLM systems will simply demand the maximum leverage in early concept and design; CDA is well positioned to provide this leverage. Imagine the design engineer who, with minimal training and experience, can assess a series of geometrical variants, or a series of unique approaches and determine within minutes the impact to performance as a function of fluid flow, heat transfer, thermal or structural stress or any number of other physical phenomena that can be simulated directly on the CAD geometry they are developing, either from within the CAD package itself, or in an integrated bidirectional (real-time) module. "Faster, better, cheaper" is the age-old mantra; CDA enables the traditional design function to engage in analysis, and if successful, will help maintain the vitality of this mantra.

According to a senior technical manager and simulation expert at a major semiconductor equipment manufacturer, "The next reality in the semiconductor industry is imminent and the key elements of this reality are time, cost and robustness – reduction in design-cycle time, time-to-production, and cost of development, and increased product robustness with high quality and reliability. The use of CAE (CFD/FEA) has become critical in creating robust products within an ever decreasing time cycle and diminishing resources. However, CAE has always been a bottleneck and been treated as "research" activity rather than "concurrent engineering" activity. In order to transform CAE from "research"

to “engineering” we must eliminate virtually all of the “non value-add” aspect of conducting an analysis. It would include such burdens as re-creating geometry (it must be derived directly from their CAD geometry), creating meshes, tuning numerical parameters, etc. Only then, CAE can become an integral part of product development process.

Moreover specialized CAE analysts are becoming a luxury in a resource-constrained environment. Therefore, design engineers must take on this added CAE responsibility, and be able to integrate it in their fast-paced design process. In today’s paradigm, this is simply not possible. The tools have not existed, and the design engineers have not had the opportunity to develop their latent capacity to perform analysis. We believe we must start with tools, and integrate these tools tightly into the development environment. It is no small challenge for both the software developers and for our own analysts and design engineers. However, we believe that once others see the results, this paradigm will become the next reality for design methodology and will become a standard within the PLM systems”.

CFD Research Corporation (CFDRC), has had a unique vantage being the only CAE company to have over 15 years of experience in conducting leading edge R&D in chemical, biological, electrical and mechanical phenomena in both macro and micro scales, while simultaneously conducting product development up to the engineering prototype level and being awarded several patents in the process. Their flagship software product, CFD-ACE+™, is a leader in CFD and multiphysics simulation. Not only have they felt their own internal push for CDA, but their customers have also clearly articulated the pull for CDA.

CFDRC embarked on an ambitious program to develop a dramatically different type of CFD tool, one that would cleanly integrate into the design workflow – a CDA tool that would couple the design and analysis, and help to usher in, or catalyze the next reality. The product has been named “CFD-CADalyzer” to represent CFDRC’s vision. It has been a product driven from the onset by the market push, particularly from future looking, strategic thinking customers “We developed a very clear vision by communicating and sharing ideas with our customers, and observation of the CAE and CAD landscape.” commented Karlheinz Peters, Senior Vice President of Software operations, and a CAD market veteran. “A key lynch pin for us was the strong support we received from our largest and most strategic customers. With a shared vision of the next reality, they helped to validate our vision before we made the substantial and some would regard, risky, investment into a new product targeted at a new market segment.”

There are other requirements that the potential markets have widely and clearly communicated. The top three are worth exploring further.

First, the entry barrier would be a function of the degree of change required to SOP, standard operating procedure and of the implementation effort, which is essentially the level of ease and speed to get an individual productive and comfortable, particularly as the perception of CFD is often characterized as useful only to an expert with little time constraints. “Our internal requirements were to align CFD-CADalyzer with our customer’s design processes, make it transparently integrated, and quickly useable by design engineers who may not necessarily be proficient or familiar with fluid dynamics. CAD-centric design processes was obvious as we observed the rapidly evolving PLM environment we see as mainstream in the future.”, explained Peters.

Second, solutions must be not just quick and easy to achieve, but accurate to the degree necessary for a particular situation. Mike Nieburg, Vice President of Marketing at

CFDRC states, “One might say this is a fuzzy area about which we have absolute clarity. Accuracy is a very tricky issue. We would like to have 100% accurate solutions in zero time in the ideal world. But the fact is, simulation fidelity is still a function of other variables or constraints, such as how long one is willing to wait for a solution. A highly accurate solution may be obtained in say one hour, but if the user wants to spend no more than five minutes per parametric run, then they must accept a reduced level of accuracy. Thus, in the absence of absolute accuracy, what is essential is one of two alternatives. Either the user must be able to define the level of accuracy needed, and reliably obtain it in the simulations, or, the degree of accuracy is made known to the user and consistently maintained for a particular combination of variables and time constraints. Some situations will require a very quantifiably accurate and detailed solution, while another may only require a gross flow prediction. The performance of one package versus another may well include the degree of accuracy each provides given all other variables are identical.”

Third, the market needs to minimize the cost of ownership. There are many components to this, but certainly one is a sound growth path. Though many designs may initially require limited fluid flow and heat transfer simulation, as CDA grows, so will the need for higher order physics, such as chemical reaction, radiation, mechanical and thermal stress and so on. “We are very fortunate to have these modules already available, tested and proven through their long time use in our flagship multiphysics software product, CFD-ACE+™.” noted Peters. The long term is where the value is going to show up, and the long term is where the sharp managers are going to be looking.”

On September 2, 2003, the first version of CFD-CADalyzer was released and as of this writing, is already being used at nearly two dozen sites. It is far too early to conclude that CFD-CADalyzer or any similar product will grow in use to establish CDA as a standard as mainstream as CAD or CAE, but the early signs are certainly encouraging. Interestingly, the early adopters have not necessarily been mainstream MCAD companies, but visionary companies in the semiconductor industry and leading edge companies in emerging sectors such as biotechnology.

“From my initial work with CFD-CADalyzer, I really like it....The ability to work with my 3D modeler and then generate a mesh with CADalyzer is outstanding.”

Craig Lanning, Professional Research Assistant at the Cardiovascular Flow and Imaging Research Laboratory, The Children's Hospital, Denver, Colorado

Operational Workflow

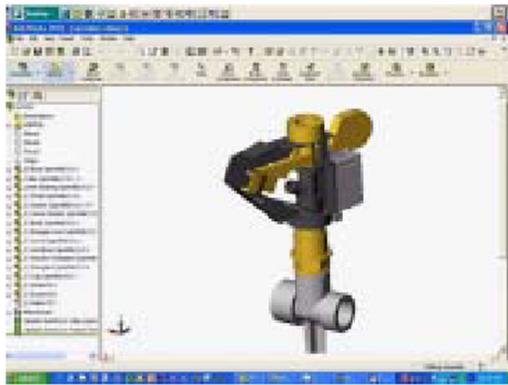
CFD-CADalyzer has been designed to work directly on the CAD model, avoiding the pitfalls associated with translation between different geometry representations. To ensure that this critical aspect of the software would be bullet proof and stay current, CFDRC turned to a third party that specializes in enabling Simulation-Based Design, Simmetrix Inc, and leveraged their Simulation Modeling Suite. This modeling suite ensures maximum integration with the design process by providing the user with robust geometry access and automatic mesh generation. With the Simmetrix engine, CFD-CADalyzer will work with any CAD package that provides a direct ACIS (Inventor, AutoCAD, etc.) or Parasolids (SolidWorks, Unigraphics, etc.) access. Soon to follow will be Granite (Pro/Engineer and Pro/Desktop).

Implementation of *CFD-CADalyzer* was given considerable thought, as the introduction of any new tool always presents a barrier, regardless of the value. *CFD-CADalyzer* has been designed with the similar tree-style look and feel environment of many major CAD packages to provide the comfort and efficiency of a minimized learning curve. Additionally, *CFD-CADalyzer* contains a powerful template mechanism that provides physics data reuse between models, which significantly simplifies setting up a new simulation.

Open Access

Sharing of results is a standard requirement in today's design environment. *CFD-CADalyzer* utilizes OpenHSF, an industry standard interface that enables models to move smoothly, and collaboratively, through all stages of the product life cycle. It also provides easy data incorporation into popular Microsoft programs, including Internet Explorer, PowerPoint, and Word.

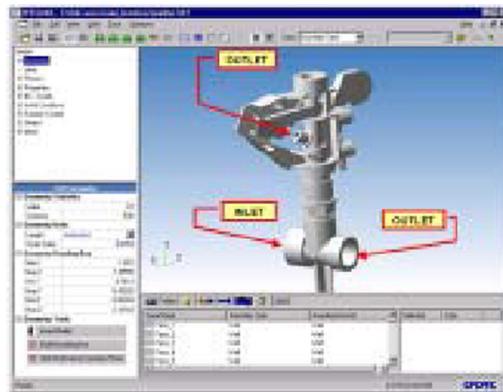
CFD-CADalyzer™ Work Flow



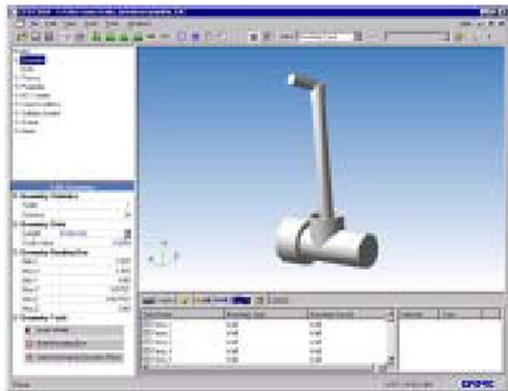
Model inside
CAD system
(SolidWorks)



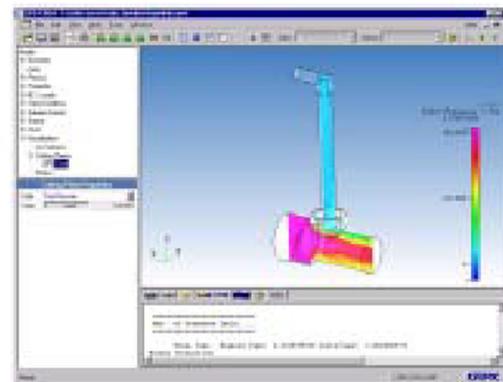
Native CAD
model inside
CFD-CADalyzer™



Fluid part of
the model
(computed by
CFD-CADalyzer™)



Display of
simulation results



Summary

Increasingly, emphasis is being placed on optimizing the *design process*, rather than optimizing the design itself. Design optimization may be an ultimate goal, but as a practical matter, Time-to-Market is the defining constraint. A robust design that has the maximum likelihood of fulfilling design requirements, the minimum likelihood of having to circle back (redesign), and gets to market “faster, better and cheaper” is still the mantra of the product development process.

Enabling the design engineer to effectively impact the final product has the potential of greatly reducing the Time-to-Market – with less resources and lower cost. Coupled Design and Analysis, CDA, is clearly the path to enable this, and will likely emerge as a new standard, along side our more established friends, CAD/CAM/CAE. CDA will be an important catalyst in the evolution and implementation of PLM systems, and CFD-CADalyzer is ready today to enable the “triple squeezed” design engineer to be successful in the next reality.

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