The evolution of pump design simulation

Pump design analysis has come a long way from the days of slide rules and drafting tables. The next step, claims Jim Spann of Blue Ridge Numerics, is putting computational fluid dynamics (CFD) and fluid flow simulation capabilities into the hands of pump design engineers. Over the past year, upfront CFD has made its mark on the pump industry, reducing the need for expensive physical tests and cutting new pump development costs by an average of 65%.

Analysis in the pump design world is changing. No Longer the province ol specialists in their own departments with powerful supercomputers and arcane software, finite element analysis (IT.A) and, increasingly, computational fluid dynamics (CFD) are being used by a broad spectrum of design engineers. Instead *n* using computer aided engineering (CAE) only for validation, usually at a point when it is too late to make significant changes anyway, design engineers are being encouraged to understand and use CAE tools at the concept stage to test design tundamenlals when major changes are relatively inexpensive.

(II) is the simulation of flows, such as the flow ol water through a pump or blood through a valve. CFD soli ware has been around for more than JO years, but it has done little to improve design in the pump industry. There are many reasons for this, hut if you ask engineering directors at typical small to medium-sized pump companies why they don't use CFD, they will probably tell you that it is difficult to learn, time consuming, and too expensive. Blue Ridge Numerics has addressed these issues with their product, CFdesign, and a vision they call'upfront (!FD\

Upfront CFD integrates flow and thermal simulation within a computer aided design ((!AD) environment. You don't have to be a dedicated CFD or CAE expert to solve complicated and challenging flow and thermal problems. The program is used by multitasking engineers during early stage product development, when innovation and intelligent problem solving are most cost effective. With upfront CFD, companies gain critical insight into pump performance early on in the design process. It cuts development time, dramatically reduces the amount of physical prototyping and testing required, and enables early exploration of pump designs m a $D virtual world.

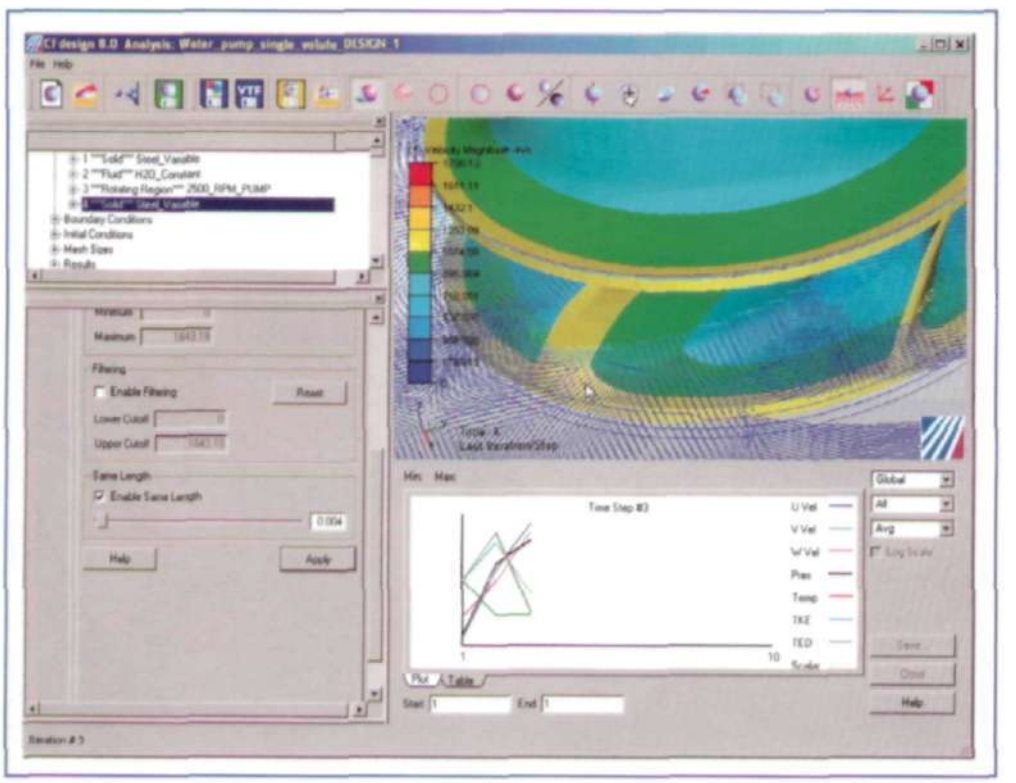

Figure 1. Alive view into the details of fluid flow through a proposed pump design.

The engineering information made available includes transient details of a whole machine's response to fluid flow on any time scale, full performance curves, impeller radial loading, analysis of single blade passage, and analysis ol intermeshing gear parts - all of which are almost impossible to determine from lab tests.

Real world innovation

There is a growing *n{*.-^\\ for upfront CFD among pump design engineers. The cost and time associated with building and testing physical prototypes has slowly been eating away at profit

margins and threatens the viability cA some pump manufacturers, I Ipfroni (IP is currently being **used in industry** to improve and **optimise** almost **every type of** pump.

Layne Bowler Pump Company is a manufacturer and distributor of vertical turbine and submersible **pumps. The** company was founded in .Ankara, Turkey in 1965 to supply Turkey'^ agricultural industry. Layne Bowler uses (IFdesign as part of its integrated CAD/CFD/CAE/ CAM process, **and the application has become** ,i vital **link in this** engineering chain.

"Designs are **tested in the** computational environment **until best performance and productivity** are achieved," **explains Onur** Orgen, a **CFD application** and **R&D** engineer .ii Layne Howler. "The software enables us to shorten the design **and tesi** periods **and to** save money on test and production costs."

Developed specifically for engineers **working with CATIA, Pro/ENGINEER, UGS NX, SolidWorks and other leading CAD systems, CFdesign turns a** standard CAD workstation into **a fully interactive flow bench, wind tunnel, or thermal tesi** rig. **It works as an extension of the** CAD application, enabling design engineers to run complicated heat transfer or fluid flow simulations during the product concept stage, long **before products enter physical testing.**

CFdesign plays a major role at Layne **Bowler because it enables the** design **team to better understand the internal flow** si iik lure ol **the pump, "bach** ease Study **allows** us to **use**

Blue Ridge Numerics

Blue Ridge Numerics puts comprehensive fluid flow and heat transfer simulation upfront in the product development process, where it creates tremendous value for small, medium, and large companies around the world. Its rapidly growing global customer list includes leaders in major vertical industries including aerospace, appliances, automotive, electronics, food and drug, HVAC, material processing, medical, military and defense, plumbing, and power generation.

First introduced in 1992, Blue Ridge Numerics' upfront CFD vision, supported by the proprietary CFdesign technology platform, saves customers money and time by reducing the amount of wind tunnel and flow bench testing.

Listed on the Inc. 500 and Deloitte Technology Fast 500, Blue Ridge Numerics is one of the fastest growing technology companies in America and the fastest growing CFD software company in the world.

Pump companies using CFdesign include: Argal, Askoll, Borg-Warner, Bristol Compressors, Compare, Copeland, DeVilbis Air Power, Ebara, Factair, Fairbanks Morse, Finish Thompson, Floway, Gardner Denver, Goodrich Pumps, IMO, Ingersoll Rand, ITT Goulds, ITT Flygt, IronPump, Lau Industries, Layne Bowler, Liberty, National Oilwell, Pentair, Pioneer, Tempo, Wabco, Waterous, Weir Floway and York.

CFdesign supports associative integration with Autodesk Inventor, CATIA V5, Pro/ENGINEER, Solid Edge, SolidWorks and UGS NX. The software also supports native interoperability with Alibre, CoCreate, IDEAS NX, IronCAD and other CAD systems based on ACIS or Parasolid geometry kernels.

different features of CFdesign in order to improve the hydraulic efficiency of our pumps," says Ozgen. "I have worked with other CFD codes on the market, but I really believe that CFdesign, especially in terms of mesh generation, allows the designer to save lots of time. Other features such as MCAD integration and post processing also make life easier for a design engineer."

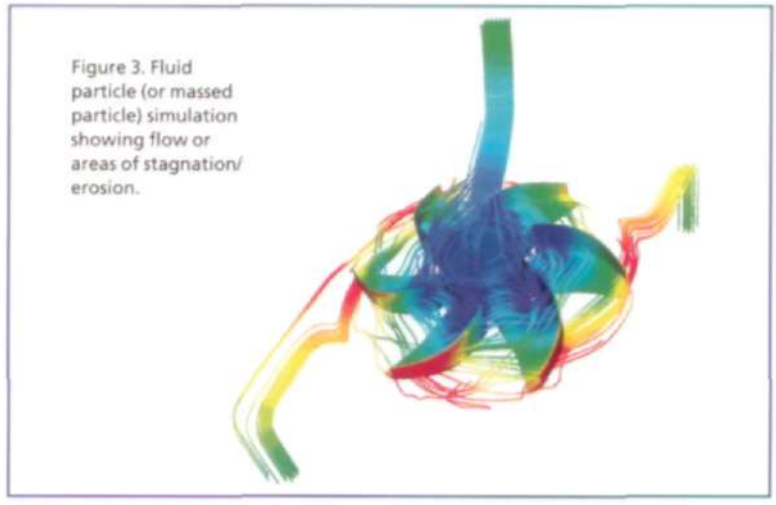

Figure 3. Fluid particle (or massed particle) simulation showing flow or areas of stagnation/ erosion.

Six pillars of upfront CFD

The upfront technology platform consists of six main pillars, which together with the operator's CAD system form a total integrated solution.

1. CAD integration

The process starts where upfront CFD belongs, in the CAD system. CAD integration is important because it simplifies the process and shortens the learning curve. With CFdesign, the CAD software drives the simulation.

2. Mesh generation

Mesh generation removes the pain from combining complex models by controlling the placement and quality of finite elements. Models that would take days to mesh in traditional CFD codes take just minutes with CFdesign.

3. Comprehensive simulation tools

CFdesign has been designed to tackle genuine real world complexity. With traditional CFD, certain scenarios, such as those involving the motion of moving parts within a simulation, present a significant barrier to engineers and even dedicated CFD analysts. In CFdesign, you simply select the moving part on the CAD model and apply a constant RPM, a motor torque, or an RPM vs. time curve to ramp up the pump during its duty cycle. Engineers can see what they have been missing on the flow bench, and, as result, are making more innovative pumps based on reliable engineering data.

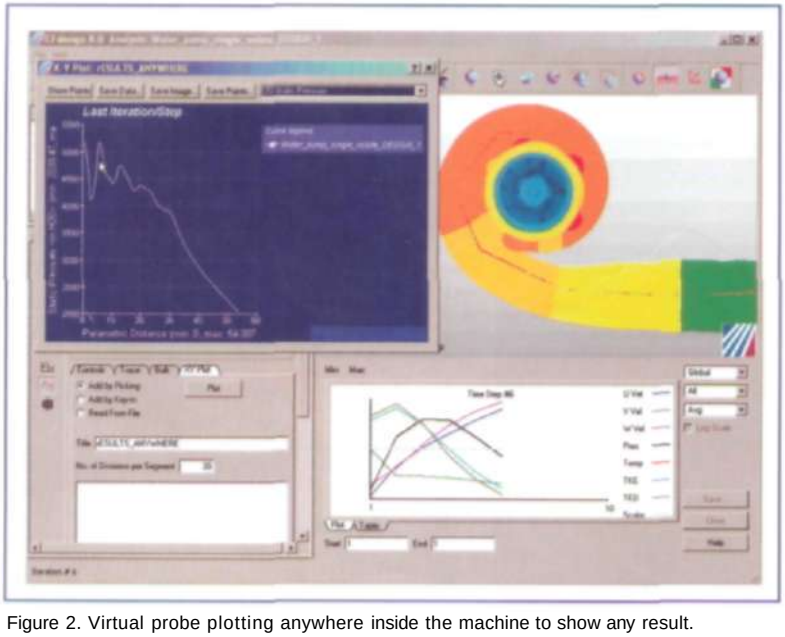

Figure 2. Virtual probe plotting anywhere inside the machine to show any result.

4. Simulation speed

CFdesign is built from the ground up to deliver fast answers on common PC hardware. In CFdesign an automated solution centre works behind the scenes, accelerating and monitoring the solution process and providing insight into pump performance that would be impossible to get from testing a physical prototype in a lab, such as when a model is completely enclosed. The flow bench can only supply a limited number of data points (mainly at the inlet and outlet), but these fail to provide full spectrum data from the internal workings of the pump. CFdesign is not bound by any such limitations.

5. Easy comparison and review

Comparing and reviewing multiple designs with traditional CAE and CFD tools is a time intensive, manual process that requires the selection of representative static views and the printing of dozens of hard copies for side-by-side review. CFdesign's design review centre enables the comparison of different options side-by-side on one screen. A designer can quickly assess if he or she is raking the design down the right path and whether or not the design can still be improved. Full performance curves can be generated

in less than ten percent of the time it takes to run out .1 prototype on a flow bench.

Figure 4. Cross-section view showing flow vectors and excessive separation at cutwater.

6. Collaboration

Being upfront in the design process absolutely requires that collaboration 1.111 happen easily between engineers, managers, and even clients. CFdesign enables complete collaboration, with helpful communication features including dynamic 3D images and instant web reports with animated 3D models embedded inside. These can be shared via e-mail or imported into standard applications like Microsoft PowerPoint or Word.

I here are companies that do not share the vision of upfront *C.VD:* it has been called CFD 'lite' or 'low-end CFD'. Only a few years ago an executive from a major traditional CFD developer equated upfront CFD to "giving guns to children." However, what has become clear within the pump industry is that upfront CFD is not a subset of traditional computational fluid dynamics, bul a new category that is being defined by the marketplace. No rhetoric should prevent design engineers from taking advantage of an opportunity tO speed product development and improve quality without leaving their familiar CAD environment.

For companies with engineering departments full of multitasking engineers whose responsibility it is to get product tO market, the true value ol CFD lies in bringing it upfront in the product development process and testing design fundamentals at a point when major changes cost very little. •

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