Simulation Powers Development of Professional Power Tools

CAE is a core element in developing high-end, long-lasting professional power tools at DeWalt, a Stanley Black & Decker brand.

By Evelyn Gebhardt

Since the invention of the first hand-held power tools more than 100 years ago, the industrial power tool industry has evolved to a very competitive and challenging market. There is a high and increasing demand for long-lasting quality tools offering power, quality and safety. These tools are used under the harshest conditions and are expected to work without any performance loss over years with little maintenance. Global and regional competition to build better tools is very high. Because of the long life cycle of power tools, a short time to market with new advancements is important for brand loyalty and staying ahead of the competition.

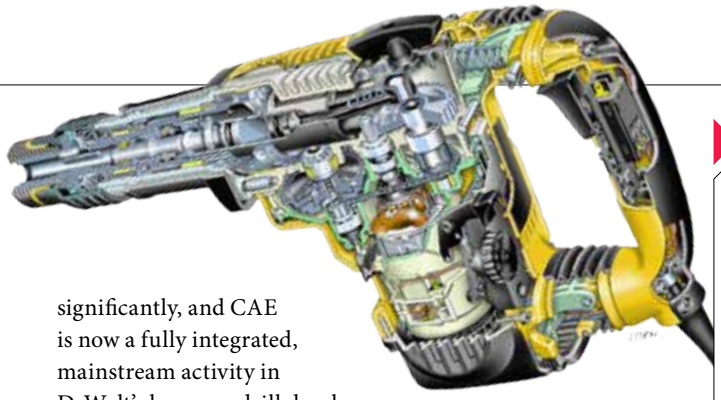
DeWalt, a Stanley Black & Decker brand, is a leading manufacturer of industrial/professional power tools with more than 300 power tools and equipment products as well as 1,000 power tool accessories, including corded and cordless drills, saws, hammers, grinders, routers, planers, plate joiners and sanders as well as lasers, generators, compressors, and nailers, among others. DeWalt tools can be found wherever tools are sold, globally.

The DeWalt brand has three development sites – one in the United States, one in China and one in Germany. The German development site in Idstein designs, develops and manufactures hammer drills for the DeWalt brand, handling everything from the initial concept to the engineering and the manufacturing. A team of engineers executes the simulation/computer-aided engineering (CAE) tasks, collaborating closely with the hammer drill design teams at the Idstein facility.

CAE Increases Global Competitiveness

Eight years ago, the DeWalt engineers took a major step to expand the use of CAE technology within their established product development process. During the learning and early adoption phases, CAE was not relied upon heavily within DeWalt's mature, proven development cycle. Since then, staff expertise and organizational confidence have grown

DeWalt, a Stanley Black & Decker brand, is a leading manufacturer of industrial/professional power tools such as this jackhammer. The company relies on CAE technology within its product development process to optimize its tools.



significantly, and CAE is now a fully integrated, mainstream activity in DeWalt's hammer drill development process.

One of the first Altair CAE tools Stanley Black & Decker/DeWalt German engineers started to use was HyperMesh®, a finite-element pre-processing software. Part of Altair's HyperWorks® CAE suite, HyperMesh is used for tasks such as meshing and model setup. Later, other HyperWorks' tools followed, among them HyperStudy® for optimization tasks; HyperView® for post-processing; and RADIOSS®, OptiStruct®, MotionSolve® and AcuSolve® for solving explicit and implicit finite-element analyses, multi-body dynamics and fluid problems.

To accelerate its development process while ensuring an unwavering commitment to quality and performance, especially for the high-end DeWalt product line, Black & Decker started to ramp up its own CAE department at the DeWalt site in Germany.

"The company realized that it had to start using virtual development tools more and that it needed to implement new development methods, extending traditional practices based on experience and physical tests," says Andreas Syma, director of Global CAE for DeWalt power tool development. "With the competition we face, especially in hammers, and the strong pressure to reach market maturity as early as possible while keeping all of our quality standards for professional tools as high as possible, Stanley Black & Decker had to enhance its development processes," he explains. "As a first step, we implemented advanced CAE methods within Dewalt's development process of hammer drills in Germany. With the success of the CAE methods and the development processes created, we are now beginning to implement these throughout Stanley Black & Decker Inc. for the development of various power tools."

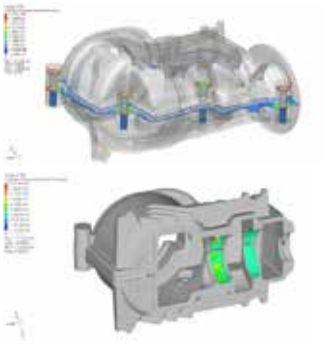
Today, the Idstein CAE team is using the entire HyperWorks suite for almost all CAE-related tasks and has also started to implement tools of the Altair Partner Alliance (APA) – a program that provides Altair customers access to third-party partner solutions through Altair's unique unit-based software licensing system. Through the APA, DeWalt engineers use FEMFAT and DesignLife for fatigue analysis as well as DSHplus in combination with MotionSolve for complex hydraulic and pneumatic systems co-simulation.

Syma notes, "I can point out three reasons why we work so extensively with Altair and its solutions. First, there is the licensing system – this is really unique in the market. You have a pool of license units you can use for every application offered under the licensing agreement.

MODELING

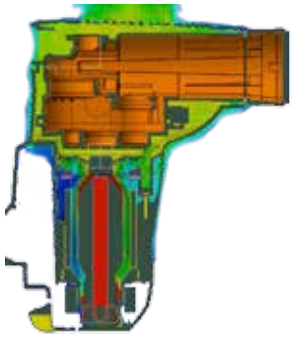
Detailed cutaway view of Dewalt's hammer drill finite-element model developed using HyperMesh®.

ANALYSIS AND OPTIMIZATION



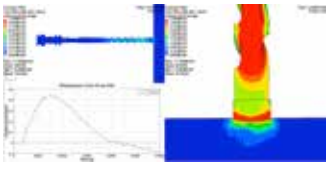
Drill hammer gear housing structural analysis for assembly and operating loads using OptiStruct®.

CFD ANALYSIS



Drill hammer airflow simulation using AcuSolve®.

IMPACT ANALYSIS



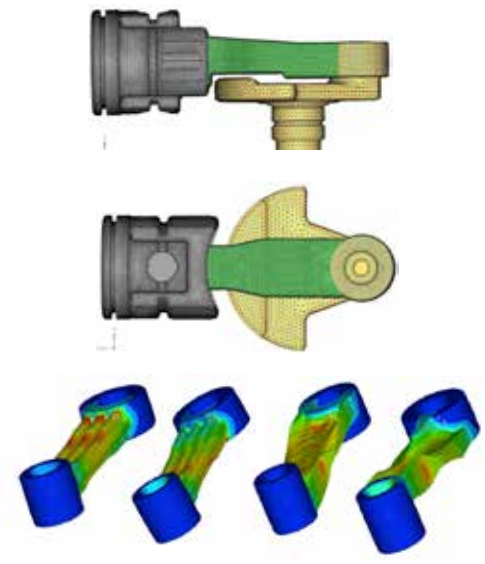
Hammer drill impact transfer and penetration analysis using RADIOSS®.

"The second reason," says Syma, "is Altair as a company itself. Altair really is an engineering company. Most of its employees are engineers, and when we talk to them, we always know that we are talking to experts who understand us, our challenges and our needs, not only as simulation and software experts but also as engineers. We regularly hold meetings with the German Altair team in Cologne, and I can say that both parties benefit from these technology-driven meetings. We give them input about new things we tested to help them improve the software, and we receive their support in using the software without opening a new project for every request – all included in the license fee for the software.

"Another important reason why we work with Altair and its solutions," continues Syma, "is that Altair offers an entire suite of CAE tools. If you also consider the Altair Partner Alliance program, you are able to handle almost every development task with HyperWorks and its partner tools, including multi-physics and co-simulation aspects."

Automation Ensures Unwavering Quality

Syma describes that a regular use of the HyperWorks suite is to simulate the power tool drop test – a very common event experienced throughout the service life of any hand-held power tool. For the virtual drop test, the engineers use HyperWorks to streamline the modeling, analysis and results visualization for multiple drop orientations to predict resulting damage in order to take corrective steps earlier in the design phase to minimize failures in the field and warranty claims. Following drop testing, a power tool has to comply with set high-quality standards, i.e. noise and vibrations. In addition, it must demonstrate no structural damage and be electrically safe.



DeWalt engineers apply co-simulation to improve the performance of products using Altair's OptiStruct® topology optimization and MotionSolve® multi-body dynamics analysis technologies. Redesigning this connecting rod using co-simulation resulted in a 25% reduction in maximum stress level and a lighter weight product.

With the virtual drop test, engineers can quickly realize any weak points and improve the design until it fulfills all quality aspects. Since the CAE engineers work closely with the design teams, iterations can be carried out very quickly and easily at a fraction of the cost and time needed for the same number of physical tests.

DeWalt engineers have also adopted the use of Altair's optimization technology very early in their new product development programs – even before the design is made. One example of how DeWalt engineers are using this method, more commonly known as simulation-driven design, is in the development and optimization of hammer mechanisms.

The hammer mechanism is a critical component of a drill hammer and combines a lot of engineering competencies. Together with Altair, Syma's team defined a parametric model – a parametric structural mesh created by applying Altair's morphing technology. By using design of experiments (DOE) and optimization methods, the engineers then automatically analyzed various variations of the geometries to see which design offered the best hammer mechanism performance.

"The implementation of a CAE-driven design process," explains Syma, "really changed our way of developing new products. It helped us to test various designs very quickly and to find the global optimum. We defined the design space and applied boundary conditions, i.e. load cases. The CAE tools then helped us to find an optimized design with the best possible performance. In a weekend, we can now calculate several hundred different model variations and create thousands of results, which we post-process automatically, to know in which direction we have to fine-tune development."

One of the major reasons to automate development processes of professional high-performance tools is the strong competition in this market. Syma says, "Our products have always been very good: they have a long lifetime, are durable and powerful. But if you

HyperWorks Unlimited HPC Appliance Improves the Capacity for Innovation

Stanley Black & Decker (SBD) is consistently seeking ways to maintain a competitive edge and bring better-performing products to market faster. One way the industry leader has learned it can accomplish these goals is by leveraging simulation-based optimization early in the design process. By running simulation software on a high-performance computing (HPC) platform, engineers can test several hundreds of designs at a time and gain new insights into product performance, durability, cost and weight.

Previously, SBD had been using workstations running LS-DYNA, with an optimization runtime of about three weeks. But this runtime was not sufficient to stay competitive – SBD's goal was to turn around a job over a weekend (i.e. less than three days).

SBD understood that it needed more computational power to meet its goals but was reluctant to invest in more hardware or compute cores. The company was concerned not only about the additional cost of the HPC resources but also about the effort to maintain and support a complex HPC system, as well as the ability to fully leverage the hardware with the necessary software licenses to keep utilization high.

SBD secured bids from three leading HPC hardware providers, but the proposed solutions did not allay their cost and complexity concerns. SBD then reviewed HyperWorks Unlimited®, a private cloud computing solution from Altair. This turnkey appliance includes pre-configured HPC hardware and software – with unlimited use of all HyperWorks applications plus PBS Works for HPC workload management.

The SBD team ran a benchmark study that proved RADIOSS and HyperStudy from Altair would be equivalent in accuracy and performance to their current LS-DYNA/optiSLang solution. SBD then moved forward with the HyperWorks Unlimited solution, choosing a 160-core system that Altair delivered and installed in just a few days.

StanleyBlack&Decker

HyperWorks Unlimited provides numerous benefits including:

- Comprehensive CAE suite with fast, powerful solvers
- Pre-configured HPC system fully managed by Altair
- Major cost savings over traditional hardware or software purchase

SBD now takes advantage of HyperWorks Units for unlimited use of all HyperWorks and PBS Works software within the appliance, supporting massive virtual exploration. By leasing the HyperWorks Unlimited appliance, SBD also shifts its HPC investment from a capital expense to an operational expense. In addition, SBD deals with a single vendor: Altair fully supports the hardware and software, from deployment to ongoing maintenance and support throughout the contract period.

don't improve your development processes and reach a faster time to market, the competition may catch up. If you want to be a leader in this market, you have to apply virtual development tools and methods. If not, you won't stay in the top list of professional tool providers. This is not only valid for drill hammers but also for angle grinders, drills, nailers and impact wrenches. In addition we have to offer the tools at a competitive price, which means that we have to develop faster and to consolidate development costs.

"Due to these reasons," continues Syma, "I see the importance of CAE in innovative product development, especially in our industry, constantly increasing. The intensive and automated use of CAE technologies is the right way to go. In the long run, we'll be able to decrease the amount of prototypes. Already, we see shorter development cycles in our product development, and we sometimes get a design right at our first development attempt. Each tool that is available earlier within the shops can be bought sooner. This increases our revenue and adds to our success."

Future Development

In a highly competitive market such as the industrial power tool market, the importance of virtual development methods and the use of dedicated CAE technologies strongly increase. To handle cost-effective development of these complex products, the implementation of CAE-driven design processes is almost mandatory.

Stanley Black & Decker has seen the benefit CAE tools bring to their development process at DeWalt Germany and will apply the methods now at their other development sites. Since last October, Syma is now responsible for all DeWalt CAE departments worldwide – bringing the successful process he and his team developed in Germany to DeWalt's other professional high-performance power tools.

"For me," Syma concludes, "Altair's offering of an entire suite for CAE applications is the best solution available in the market to support innovative product development. It includes close to everything we need on a very high level and all under one licensing system – from pre-processing to optimization tools and solvers to post-processing. With the recent deployment of Altair's new CAE high-performance computing appliance, HyperWorks Unlimited, HyperWorks really is the best solution for our organization to cost-effectively scale to handle the varying, complex simulation requirements across our entire product portfolio." C2R

***Evelyn Gebhardt** is a contributor to* Concept To Reality *magazine.*

For more information on HyperWorks and HyperWorks Unlimited, visit www.c2rmagazine.com/2015