SIEMENS

Ingenuity for life

Siemens Digital Industries Software

Training the next generation of engineers

siemens.com/software

Contents

Mechanical Analysis package is part of the Mentor, a Siemens Business, Higher Education Program

Mentor, a Siemens Business, founded the Higher Education Program (HEP) to further the development of skilled engineers. The program provides universities, colleges and schools with leading-edge design tools for classroom instruction and academic research to help ensure that engineering graduates enter into industry proficient with state-of-the-art tools and techniques. Through HEP, we strive to develop long-term relationships with engineering schools and universities around the world. To date, we are proud to have partnered with more than 1,600 academic institutions worldwide.

Program benefits

Mentor's Higher Education Program supports engineering education by providing simulation software, technical support, training and resources for use in teaching, class work and academic research during school and post-graduation. HEP members have access to:

- As many copies of the software as needed
- The same customer support services as corporate customers
- Mentor-advertised public training classes on a space-available basis and on-demand training (for nominated faculty staff members)
- Online product demonstrations and tutorials

Under the Mentor Higher Education Program, products are organized in design packages from which program members will choose based on their needs. Upon admittance to the program, members will receive licenses for all products in the package(s) that they choose.

Mechanical Analysis package

The HEP Mechanical Analysis package ensures that engineering students have access to the latest computational fluid dynamics (CFD), electronics thermal design, electromagnetic field simulation and fluid systems simulation software used in industry. From high school programs to higher degree university research, our physical simulation software provides both the ease-of-use and technical depth needed for all educational needs. The design package contains only full capability software versions without reduced feature sets or artificial limitations. Currently, the HEP Mechanical Analysis package contains the following simulation tools:

General purpose CFD

Simcenter™ FLOEFD™ software is a full-featured 3D CFD analysis solution built into major mechanical computer-aided design (MCAD) systems. Simcenter FLOEFD enables users to move CFD simulation early into the design process where it can help engineers examine trends and dismiss less desirable design options. Fast to learn and easy to use, Simcenter FLOEFD eliminates the workflow complexity and meshing overheads of old-school CFD software.

- Simcenter FLOEFD (including all modules)
- Simcenter FLOEFD for Siemens NX™ software (including all modules), and
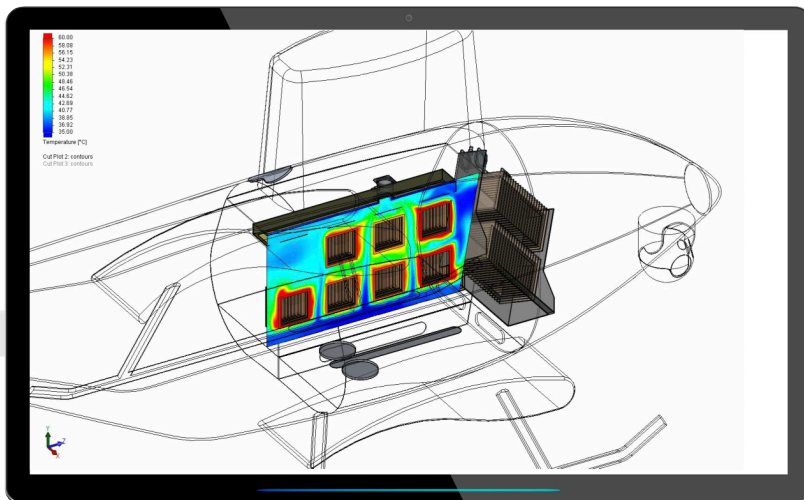- Simcenter FLOEFD for Solid Edge® software (including all modules)

For more information about Simcenter FLOEFD visit https://www.plm.automation.siemens.com/global/en/products/simcenter/floefd-siemens-nx.html

Simcenter is a part of the Xcelerator™ portfolio, a comprehensive and integrated portfolio of software and services from Siemens Digital Industries Software.

Fluid systems simulation

Simcenter Flomaster™ software, formerly known as Flowmaster, is the leading general purpose 1D CFD solution for the modeling and analysis of fluid mechanics in complex piping systems of any scale. It helps systems engineers to simulate pressure surge, temperature and fluid flow rates system-wide accurately and quickly to better understand how design alterations, component size, selection and operating conditions will affect the overall fluid system performance.

For more information about Simcenter Flomaster visit https://www.plm.automation.siemens.com/global/en/products/simcenter/flomaster.html

Electronics thermal design

The powerful Simcenter Flotherm™ software suite predicts airflow and heat transfer in and around electronic equipment. Simcenter Flotherm helps save design time and reduce the need for physical prototyping from components and boards to complete electronic systems and data centers. Simcenter Flotherm is a thermal simulation solution that can be used during all stages of the electronics design process – from conceptual design to manufacturing.

- Simcenter Flotherm XT software
- Simcenter Flotherm
- Simcenter Flotherm PCB software

For more information about Simcenter Flotherm visit https://www.plm.automation. siemens.com/global/en/products/simcenter/ flotherm.html

Ventilation and thermal design of buildings

Simcenter Flovent™ software is a powerful CFD software that predicts 3D airflow, heat transfer, contamination distribution and comfort indices in and around buildings of all types and sizes. The fast and easy-to-use user interface in Simcenter Flovent is designed specifically for engineers involved in the design and optimization of heating, ventilating and air conditioning.

Electromagnetic field simulation

Simcenter MAGNET™ software is a powerful simulation software for the design of motors, sensors, transformers, actuators, solenoids or any component with permanent magnets or coils. With this easy to use and accurate software, simple to complex electromagnetic and electromechanical devices can be prototyped and multiple configurations explored.

For more information about Simcenter MAGNET visit https://www.plm.automation. siemens.com/global/en/products/simcenter/ magnet.html

Electric machine design software

Simcenter Motorsolve™ software is the complete design and analysis software for induction, synchronous, electronically and brush-commutated machines. Simcenter Motorsolve simulates machine performance using equivalent circuit calculations and a unique automated finite element analysis (FEA) engine. The template-based interface is easy to use and flexible enough to handle practically any motor topology.

For more information about Simcenter Motorsolve visit https://www.plm.automation. siemens.com/global/en/products/simcenter/ motorsolve.html

Tools
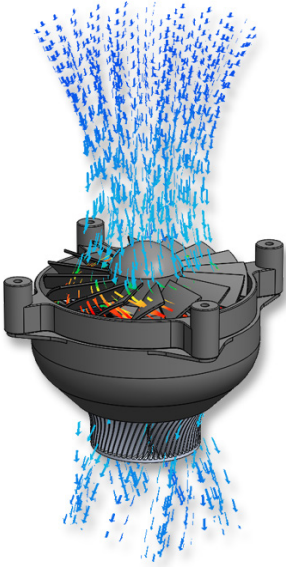
Simcenter Flotherm

Simcenter Flotherm Free Viewer Ap SW

Simcenter Flotherm 4 CC Par Solver Op SW

Simcenter Flotherm Parallel Ap SW

Simcenter Flotherm PCB Ap SW

Simcenter T3STER Auto Calibration Op SW

Simcenter Flotherm XT Ultra Ap SW

BCI ROM+Thermal Netlist Extraction Op SW

Simcenter Flotherm Pkg Creator Op SW

Simcenter FLOEFD

Simcenter FLOEFD Standalone Ap SW

Simcenter FLOEFD Electric Cooling Op SW

Simcenter FLOEFD EC Center Bnd SW

Simcenter FLOEFD Drafting Module Op SW

Simcenter FLOEFD HVAC Module Op SW

Simcenter FLOEFD for Siemens NX Ap SW

Simcenter FLOEFD NX PrePost Op SW

Simcenter FLOEFD LED Module Op SW

Simcenter FLOEFD for Solid Edge Ap SW

Simcenter FLOEFD Power Electric Op SW

Extended Design Exploration Op SW

Simcenter Flomaster

Simcenter Flomaster HEP Ap SW

Electromagnetics products

Simcenter MAGNET Design Optimization 2D+3D Op SW

Simcenter MAGNET + Electric + Thermal Suite Bnd SW

System Model Generator Op SW

PSIM Plug-in: Co-simulation Op SW

Simulink Plug-in: Co-simulation Op SW

Trajectory Evaluator Assistant Op SW

Simcenter Motorsolve Suite Bnd SW

Thermal Module in BLDC and IM Op SW
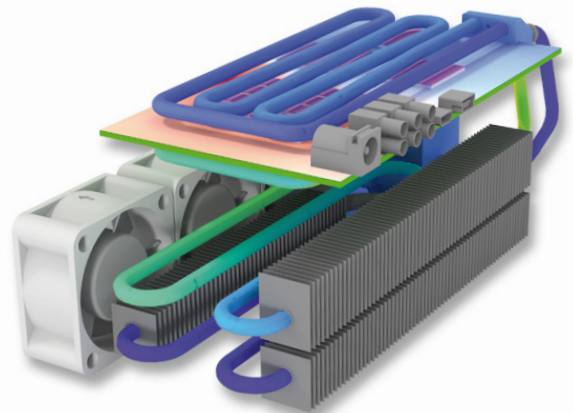
Generator module in BLDC Op SW

Simcenter Flovent

Simcenter Flovent Parallel Ap SW

Simcenter Flovent 4 CC Par Solver Op SW

FloMCAD Products

Simcenter MCAD Bridge Ap SW

Program membership

The mechanical analysis package, part of Mentor's Higher Education Program, is open to all educational institutions. Criteria for a HEP membership are:

- The applicant school must be an accredited educational establishment that awards national or state-registered degrees or diplomas. This includes degree-granting military schools.
- The software is to be used in the classroom or for graduate research projects only. These research projects are reviewed on a case-by-case basis by the Siemens Academic Program team.
- National laboratories, federally funded research and development centers (FFRDC), national centers or facilities operated by an academic institution for national governments, or wholly government-funded research centers or scientific facilities are not eligible for membership in the Higher Education Program.
- Each institution must maintain a customer support contract.
- The institution must host Siemens Digital Industries Software licenses on a single server.

The software is donated and a nominal annual support charge is levied based on the design package(s) used, irrespective of the number of licenses.

Siemens Digital Industries Software academic representatives as well as the members of the Siemens worldwide distributor network are prepared to help with more information, other international pricing, membership applications or any other enquiries around HEP. For contact details visit:

- HEP representatives: www.mentor.com/company/higher_ed/contact/
- Worldwide distributors: www.mentor.com/company/worldwide_distributors/

There are also online forms for new membership applications and membership renewals available at: www.mentor.com/company/higher_ed/application/

Design Package	Americas	Europe	Pacrim	Japan
Mechanical Analysis Package	US $990	€ 990	US $990	JPY 165600

CFD software in engineering education and research

Team Bath Racing takes to the track with improved thermal performance

University of Bath, Bath, United Kingdom
Software: Simcenter Flomaster
Application: Automotive

Team Bath Racing is a group of undergraduate engineers at the University of Bath who each year design and build their own single-seat open wheeled race car to enter into Formula Student competitions around the world. In the final year of the project the team designed the thermal management system for the car. After some research they decided to use Simcenter Flomaster as part of the design process. The ultimate goal was to use Simcenter Flomaster to create a representative transient thermal model of the vehicle's cooling and lubrication system. This included the engine, turbocharger, radiators, pumps, piping, header tanks, oil cooler and fans. To begin the design process, maximum temperature boundary conditions were set and then several experiments were conducted to obtain the necessary inputs for the transient model. With the help of Simcenter Flomaster, the team reduced the cost, time and resources needed to physically test aspects like different size oil coolers and their position in the cooling system, fan sizing, electric water pump sizing, pipe diameter selection and control strategies. A model was set up for future years to benefit as well. This also saved some weight from the car and helped them to better understand how the cooling and lubrication system works. Read more: http://go.mentor.com/52kAa

Early stage analysis of electric vehicle power electronics liquid cooling system designs

Changwon National University, Korea
Software: Simcenter Flomaster
Application: Automotive

One aspect of fuel cell design that is of particular concern is the heat generated due to the inefficiencies involved with the process. Considering a vehicle that is powered up to 100kW with a typical conversion efficiency of 90 percent in the power electronics, this would require up to 10kW of heat to be handled by the cooling system. For these designs, liquid cooling has an advantage over air due to its higher heat capacity and thermal conductivity. As a result, significant research has gone into different methods to enhance the cooling performance of liquid systems. The need to design a cooling system to meet the heat dissipation requirements of the power electronics is best carried out using a 1D CFD tool

such as Simcenter Flomaster since its focus is on system level performance. However, to accurately model a system in 1D CFD, the software requires performance characteristics of the different components that make up the system. There are several sources for generic loss or heat transfer data, but since the design information for the components was available, the use of 3D CFD meant a potentially more accurate solution. We were able to eliminate a potentially costly failing design and focus time and resources to optimizing a solution for the cooling systems.
Read more: http://go.mentor.com/4Sw2e

9

Implementing practical fan curves in datacenter simulations

**State University of New York, U.S.**
Software: Simcenter Flovent
Application: Datacenters

Datacenters are among the most energy-consuming facilities. We use CFD to model variable flow devices that exist in a typical datacenter. It is often assumed when performing datacenter simulations that the volumetric air flow rates provided by a computer room air conditioning (CRAC) unit and a server are constants. The assumption investigated was how large is the ratio of "external" to "internal" losses in a datacenter, and what impact could this have on the commonly used fixed flow rate in the modeling method of the CRAC units and the servers. The methodology to evaluate the CRAC fixed flow rate assumption involves the creation of a datacenter model and using the object specific results reporting in Simcenter Flovent to extract the external system impedance for each CRAC unit, followed by calibration of the internal flow resistance definition to match the observed flow rate with the manufacturer's blower performance curve. The variation in flow rates from the calibrated fan curve CRAC models was less than one percent of the average CRAC unit flow rate. This data suggests that the common fixed flow rate assumption for CRAC units would produce satisfactory results in this model.
Read more: http://go.mentor.com/4Sw2s
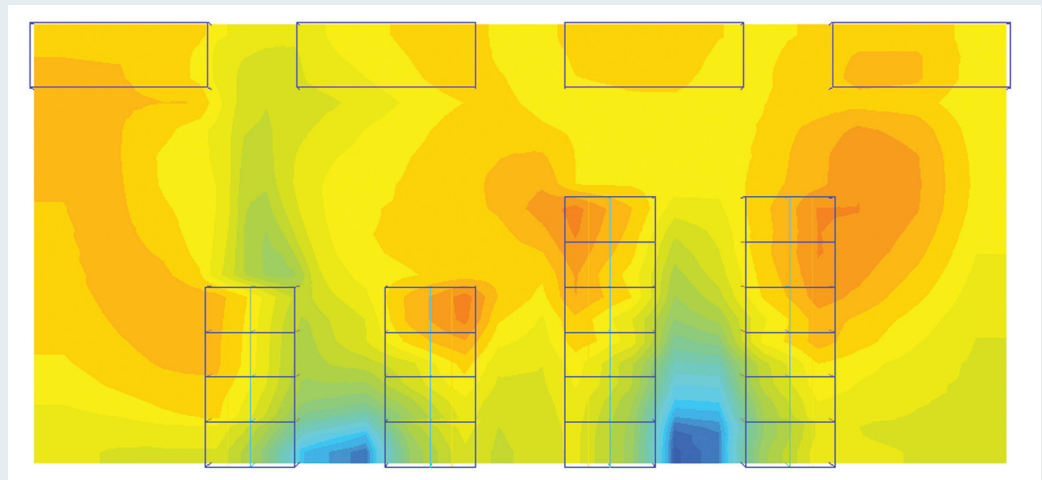
Fluid dynamics simulation of aqueous humor in a hole implantable collamer lens

**Kitasato University School of Allied Health Sciences, Japan**
Software: Simcenter FLOEFD
Application: Medical

Implantable collamer lenses (ICL) have many advantages in the treatment of refractive errors, especially for cases involving high and moderate ametropia. However, cataract development has been a concern after ICL implantation. One of the causes of the cataract was thought to be a change in the circulation of the aqueous humor to the anterior surface of the crystalline lens. Therefore, Professor Kimiya Shimizu created a centrally perforated ICL in 2006 to improve aqueous humor circulation in addition to work performed on the development of the Hole-ICL. We investigated the fluid dynamics of the aqueous humor in a Hole-ICL using the thermal-hydraulic analysis software program Simcenter FLOEFD. Our results suggest that Hole-ICLs improve the circulation of the aqueous humor to the anterior surface of the crystalline lens. The Hole-ICL is expected to continue to lower the risk of cataracts.
Read more: http://go.mentor.com/4Sw2C
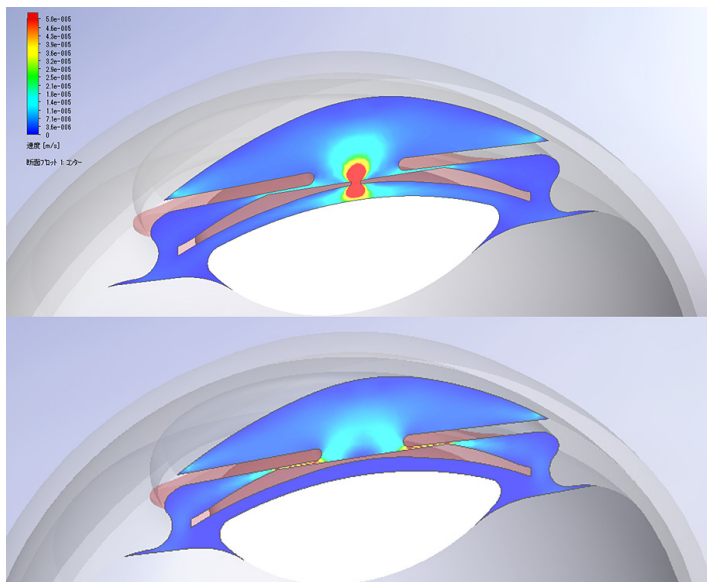
CFD software in engineering education and research *continued*

High school students fly with Simcenter FLOEFD

Real World Design Challenge, U.S.
Software: Simcenter FLOEFD
Application: Aerospace

The Real World Design Challenge (RWDC) is an annual high school competition in the U.S. run by a public-private partnership with the goal of assisting in the increase of the science, technology, engineering and mathematics (STEM) workforce in America. Every year teams of three to seven secondary school students are asked to address a real challenge that confronts leading engineers. Often students are asked to design a plane or car looking at the forces of lift, weight, thrust and drag with the goal of either enhancing performance or fuel efficiency. RWDC chose Simcenter FLOEFD from Mentor, a Siemens Business, because it is a fully-embedded general purpose CFD tool within the popular MCAD product lines. In addition, the unique push-button geometry and mesh generation pre-processing capabilities of Simcenter FLOEFD makes it ideal for high school students to pick up and use with minimal supervision.
Read more: http://go.mentor.com/4Sw2D
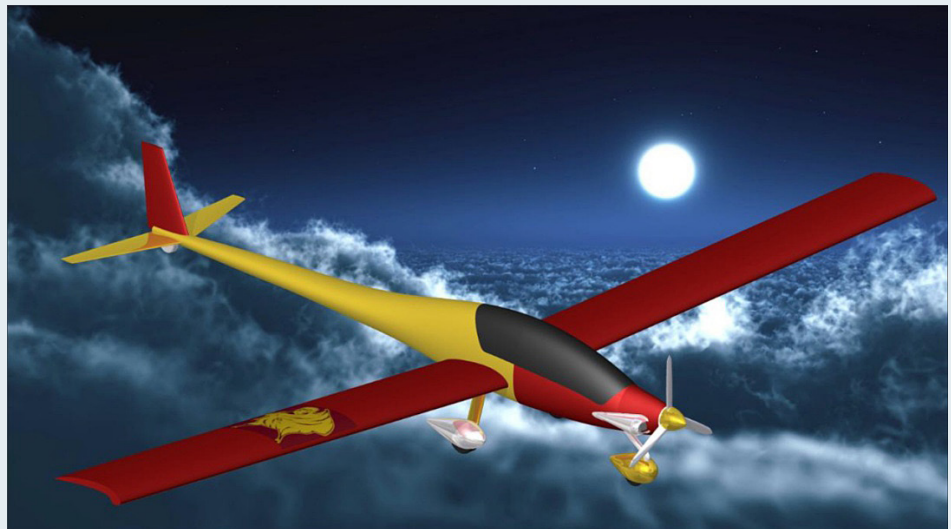
## Detailed CFD study to optimize multicompact heat sink designs

Hanyang University, Korea
Software: Simcenter Flotherm
Application: Electronics cooling

Mobile cellular phone subscriptions hit the six billion mark worldwide in 2011, resulting in an increased demand for base stations. This in turn drives the need to build even smaller, more unobtrusive compact stations. Under these circumstances, more compact heat sinks become critical to keeping component temperatures below threshold levels for optimal electronics performance. A 2010 study conducted by engineers at the Hanyang University in Seoul addressed this issue using the market-leading Simcenter Flotherm electronics cooling simulation tool from Mentor, a Siemens Business. Simcenter Flotherm CFD simulations

obtained the temperature distribution in the unit for extreme operating conditions. PIAnO was employed to execute an array of CFD simulations needed for a design of an experiment and to automate the procedure for the multivariable design scenario. This design optimization study resulted in a reduction of volume of the base station unit by 41.9 percent while satisfying all the design constraints. Read more: http://go.mentor.com/4Sw2H
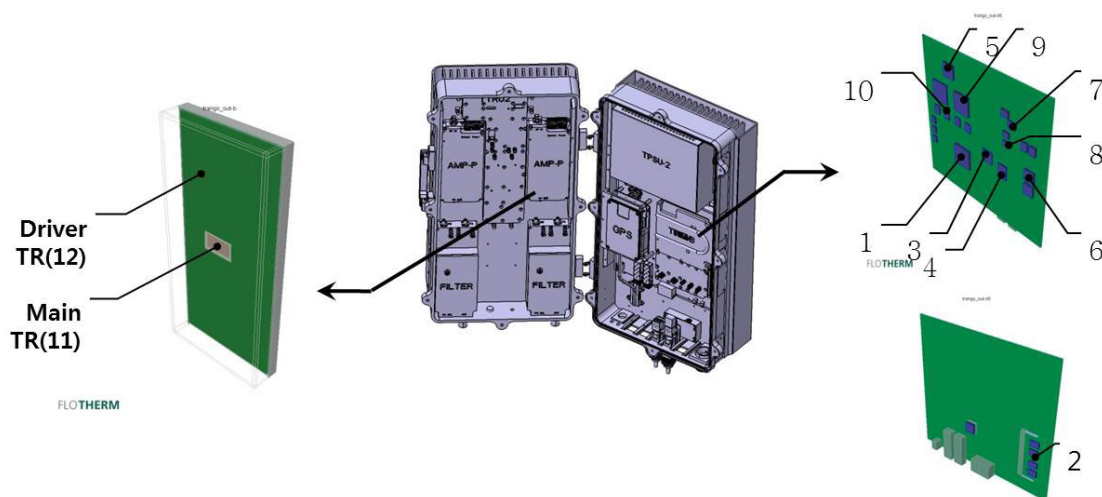
CFD software in engineering education and research *continued*

Design guidelines for a piezoelectric microblower fan sink
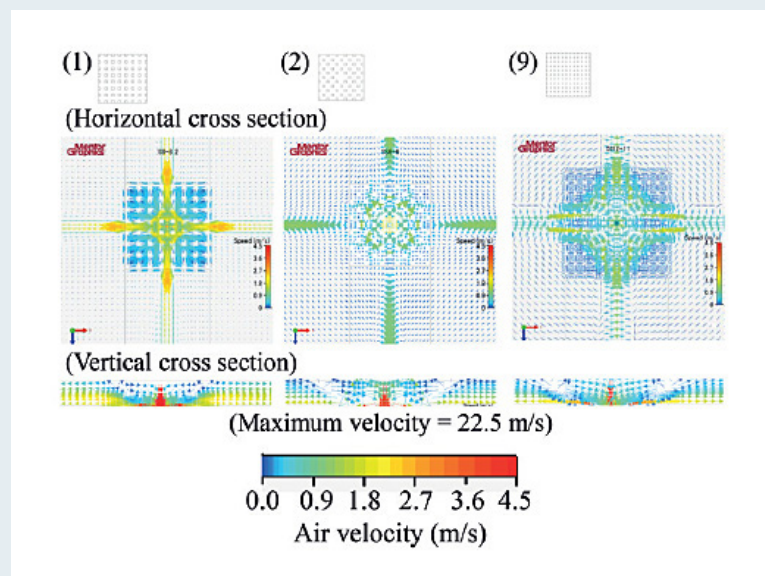
Iwate University, Japan
Software: Simcenter Flotherm
Application: Electronics cooling

In recent years, office automation equipment such as printers and a variety of mobile devices have undergone massive improvements in multifunctionality and performance, coupled with miniaturization. As a result, the thermal design has become more challenging. However, forced air cooling is needed to achieve the required cooling performance and prevent overheating. To address this, a number of small air cooling devices have been developed in recent years. In this study, we investigated the practical use of a small air-cooling device for use within the narrow gaps found in densely packed electronics. This was investigated in conjunction with a heat sink, optimized using Simcenter Flotherm to get the best thermal performance from the blower. This work has shown the viability of using a commercially available piezoelectric microblower with a customized heat sink design to cool densely packed electronics as found in the latest office automation products and mobile devices.

Read more: http://go.mentor.com/4Sw35

(1)   (2)   (9)

(Horizontal cross section)

(Vertical cross section)

(Maximum velocity = 22.5 m/s)

0.0 0.9 1.8 2.7 3.6 4.5

Air velocity (m/s)

Reading between the thermal lines: New dielectric materials for LED packages

**Technische Universität Darmstadt, Germany**
Software: Simcenter Flotherm
Application: Electronics cooling

One of the main aims in electronic packaging is a good heat transport away from the device, downwards through the package into the board. The light-emitting diode (LED) chip is connected electrically at its top and bottom. That is why there is a need to separate the electric circuit from the metal board. This is achieved by an insulator layer, which is neither electrically nor thermally very conductive.

In this study, the thermal behavior of new dielectric materials in LED packages is investigated. Furthermore the influence of geometric parameters of the electrical layout has been tested by measurements and simulations. Read more: http://go.mentor.com/4Sw36
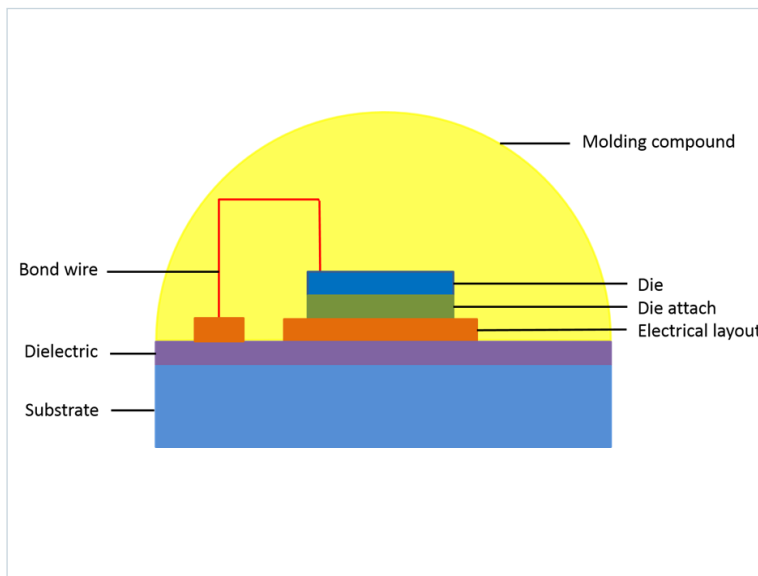
CFD software in engineering education and research *continued*

Investigation of the four-quadrant behavior of a mixed flow diffuser pump with CFD methods and test rig evaluation

Graz University of Technology, Austria
Software: Simcenter Flomaster
Application: Manufacturing

Generally, the behavior of centrifugal pumps is well known under normal operation of forward flow with a forward rotational direction of the pump. However, there are scenarios where the pump will need to run outside of a normal operating mode. An example of this is a pump trip, where to reliably calculate system transients like maximum or minimum internal pressures it is necessary to obtain performance data for all quadrants of operation. While it is possible to determine this information through physical testing, it is expensive, so the ability to generate accurate four-quadrant pump characteristics using CFD can be valuable. The simulation was carried out using a full 360

degree model with traditional 3D CFD software. The experimental measurements were made at the Institute of Hydraulic Fluid Machinery at Graz University of Technology. To further demonstrate the effectiveness of creating performance data with 3D CFD, a pump trip simulation was conducted using Simcenter Flomaster.
Read more: http://go.mentor.com/4SvII
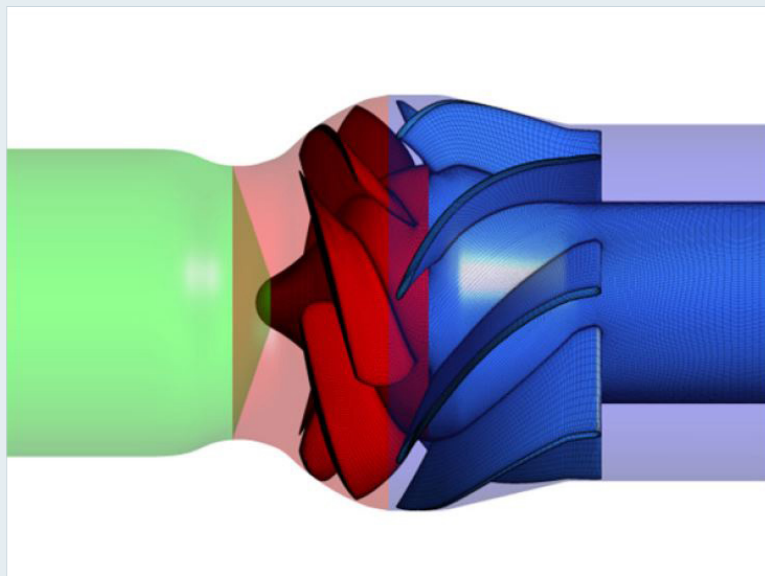
Nuclear power station thermal-hydraulic safety

**North China Electric Power University, China**
Software: Simcenter Flomaster
Application: Power generation

Safety and reliability are the most important considerations in the operation of nuclear power stations. The auxiliary feedwater system is designed to provide water for steam generators in certain scenarios. Its safety function is to prevent damage to the reactor core and get rid of the heat buildup in the reactor core until the residual heat removal system is put back into operation after a failure. The inability of this system to operate properly when the primary systems fail can be catastrophic. By using the transient analysis module of Simcenter

Flomaster for the studies of transient operation of auxiliary feedwater system of Daya Bay Second-Generation Nuclear Power Station, North China Electric Power University was able to compare the results of the different configurations and make several conclusions.
Read more: http://go.mentor.com/4Sw3i
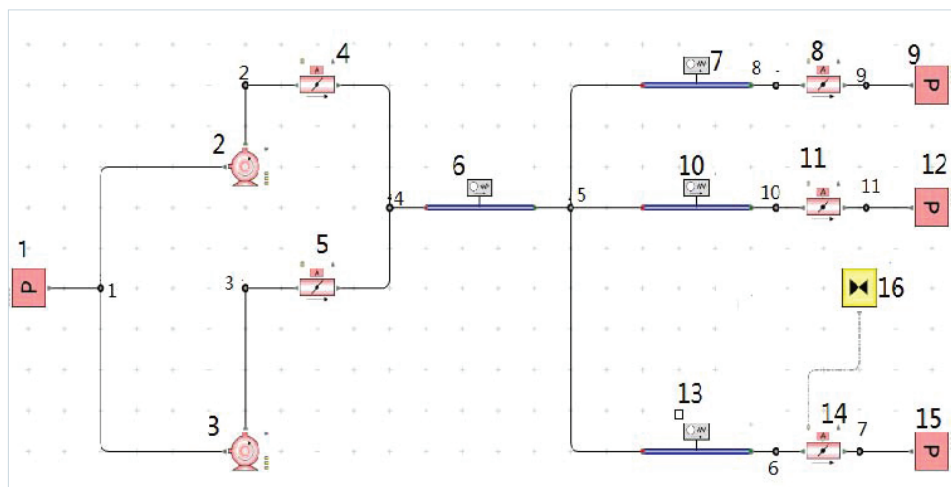
Thermal investigation of a battery electric vehicle with a coupled Matlab – Simcenter Flomaster simulation

**University of Stuttgart, Germany**
Software: Simcenter Flomaster
Application: Automotive

By design, battery electric vehicles are more energy efficient than combustion driven vehicles, resulting in much less wasted heat to warm the passenger cabin. Therefore, the cabin has to be heated with energy delivered from another source or from the battery. Markus Auer of the University of Stuttgart explores the influence of battery temperature and air conditioning (passenger comfort) on the battery and the range for the vehicle.

A Simcenter Flomaster model was set up and linked with Matlab/Simulink to simulate the vehicle, including a complex battery thermal model.
Read more: http://go.mentor.com/4Sw3n
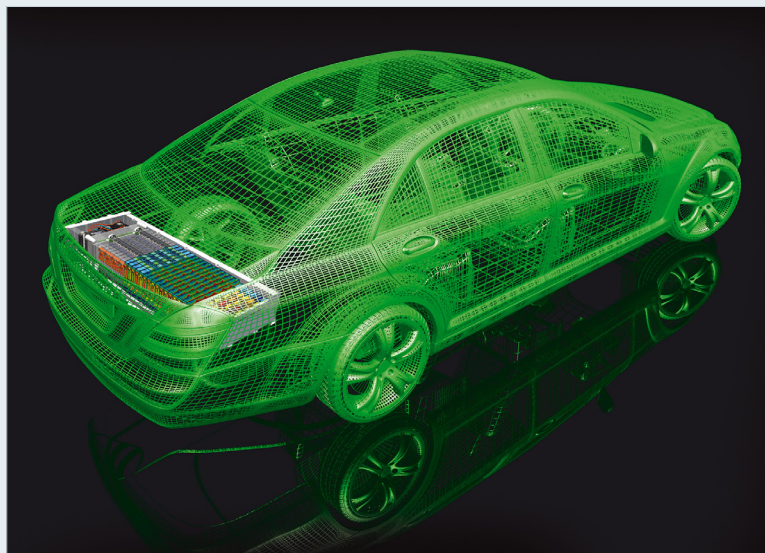
Frequently asked questions

How do I become a member of the Higher Education Program?

Visit our website at www.mentor.com/company/higher_ed and complete the application form for first-time users. It is highly recommended that you browse the site first, particularly the Higher Education Program brochure, to see exactly what we offer and how it is packaged. Then when you go to complete the application, you will have a better idea of what you want to order. Be advised that it is in your best interest to provide detailed information about the classes that will be offered as that will expedite the approval process. Once your application is approved, you will be sent a formal quote for the support fee and a license agreement that will need to be signed and dated by an authorized signer. Upon receipt of the completed agreements and payment, we will provide you with a site number and the codes for your software via email and the software will be shipped overnight.

How do I get support for the Higher Education Program?

If you are a member of faculty or staff at a participating university, you may direct your questions and issues regarding software installation and licensing to Mentor's customer support, using SupportNet at support.mentor.com.

Once you become a member of the Higher Education Program, you can go to the support website at support.mentor.com and register. SupportNet registration takes only a few minutes. To register you will need your standard contact details, your university email address, and your Mentor site number. Faculty and staff may have full access to SupportNet. Students may register for SupportNet Knowledge Access to use TechNotes, AppNotes, and Documentation.

How do I get training? What training opportunities are available?

Our standard public training is available to up to two previously approved faculty and teaching staff members on a space-available basis at each of the sessions listed on the website www.mentor.com/company/higher_ed/training/. You need to call in your registration and let them know you are a member of the Higher Education Program to get the class free of charge.

Can we get access to distance learning?

We can provide support for distance learning programs on a case-by-case basis. Please contact the Higher Education Program for more details.

I am a student in a class that is using your tools. Do I have access on my own?

The Higher Education Program donates software to universities and technical colleges, and therefore we cannot support individual students. If you would like to use Mentor tools for your degree courses and projects, please contact your professor and let him/her know about the Higher Education Program.

Can I get node-locked licenses?

The Higher Education Program does not support node-locked licenses – we only support floating licenses on a single or redundant server configuration. However, we do now offer the ability to access the tools remotely via a secure virtual personal network (VPN) provided by your system administrator. Please contact the Higher Education Program to update your license agreement.

We are currently members of the Higher Education Program. How do we get additional software?

There are two ways you can receive additional software: you can either request the additional software packages when you complete your annual renewal, or if you are mid-cycle, you can go to the website and complete a renewal application form and request only those packages you wish to add to your existing account. We will then provide a quote to cover the additional support fee for the new additional packages.

Can I get all versions of a specific software package, including older versions?

We only provide the latest release of the tools. Automatic upgrades are provided as part of the renewal process and are covered by the annual support fees.

For more information visit www.mentor.com/company/higher_ed/

About Siemens Digital Industries Software
Siemens Digital Industries Software is driving
transformation to enable a digital enterprise where
engineering, manufacturing and electronics design meet
tomorrow. The Xcelerator portfolio helps companies of
all sizes create and leverage digital twins that provide
organizations with new insights, opportunities and levels
of automation to drive innovation. For more information
on Siemens Digital Industries Software products and
services, visit siemens.com/software or follow us on
LinkedIn, Twitter, Facebook and Instagram. Siemens Digital
Industries Software – Where today meets tomorrow.

Headquarters: +1 972 987 3000
Americas: +1 314 264 8499
Europe: +44 (0) 1276 413200
Asia-Pacific: +852 2230 3333