

ACADEMIC

University of Cincinnati

Empowering the next generation of engineers with leading-edge technology

Products

NX, Simcenter

Business challenges

Produce outstanding engineers and scientists

Transform engineering and applied science curricula with advanced technology

Drive the state of the art in engineering technology

Keys to success

Focus on hands-on learning for workforce readiness

Apply new methodologies and technologies in engineering education and research

Train students on software used in the field by 140,000 companies globally

Partnership and close collaboration with Siemens Digital Industries Software

Results

Established an innovative simulation and modeling technology research center

Vertically integrated simulation technologies in engineering curricula

Provided students with elevated placement, higher earning potential and greater post-graduate opportunities

Siemens solutions drive new methodologies and technologies in engineering education and research

Real-world, experience-based learning

The University of Cincinnati (UC) College of Engineering and Applied Sciences (CEAS) unleashes education by immersing students in a rigorous and innovative curriculum and culture of real-world, experience-based learning. A CEAS degree provides graduates with elevated placement, greater earning potential and unlimited post-graduate options.

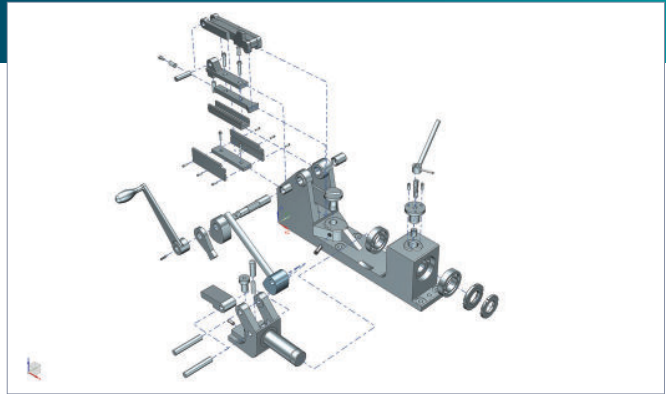
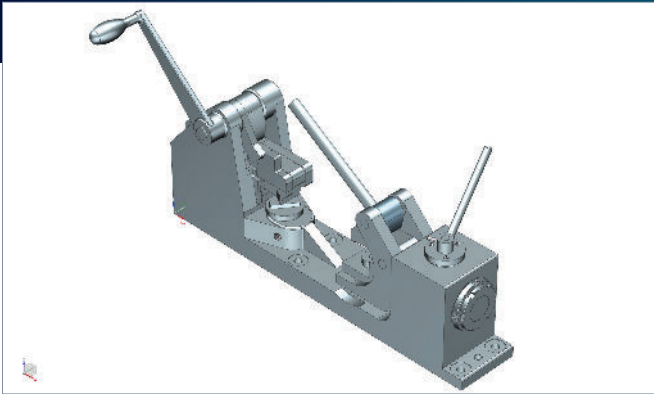
UC CEAS has built relationships with more than 1,200 companies across the globe, ranging from research to industry opportunities to expand students' professional horizons with experiential learning. The university's diverse research facilities provide

a challenging environment for students to learn and innovate. Students work with faculty mentors to discover new breakthroughs in science and technology.

The college's research centers and labs include the UC-Siemens Simulation Technology Center, established in 2016 as a hub for developing and applying new methodologies and technologies in engineering education and research. UC's partnership with Siemens has deep roots, beginning more than a decade ago when UGS Corp. (now Siemens) announced an in-kind software grant to the university, the largest software grant ever received at UC. The grant included NX™, Solid Edge® and Teamcenter® software suites to help students and faculty in the CEAS conceive, design, engineer and validate projects using the same tools used by leading global manufacturers.



Lap simulator using Simcenter Amesim.



This connecting rod straightener assembly is a typical project that first-year engineering students complete using NX software.

// One cannot realize the extent to which input commands are restricted in their flexibility in traditional CAD programs until the command options in NX are experienced."

John Ucker
Adjunct Professor
University of Cincinnati

In the years since that initial grant, Siemens has expanded the solutions available to UC to include the full Siemens Digital Industries Software portfolio, putting students at the College of Engineering and Applied Science on the cutting edge of technology.

Vertically integrating engineering courses

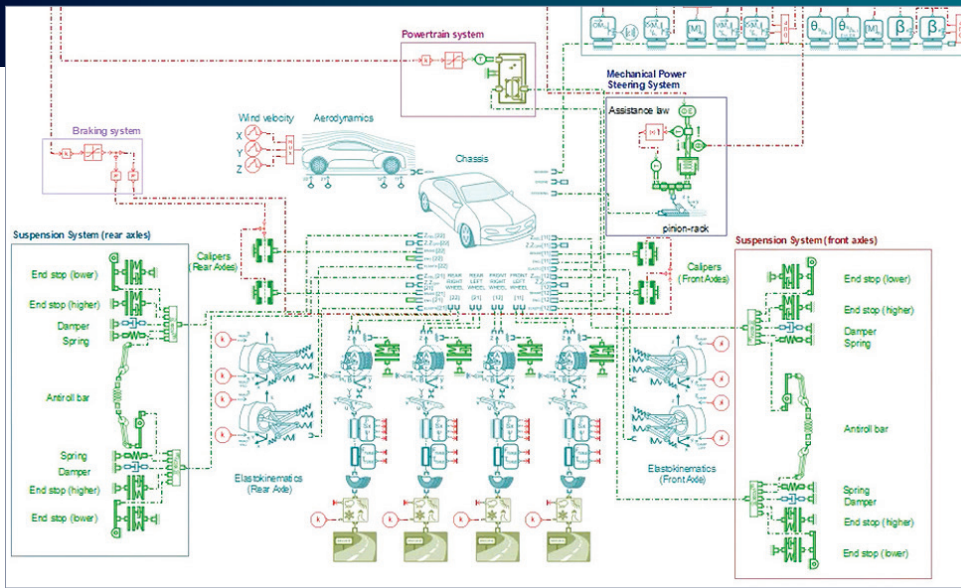
The UC-Siemens Simulation Technology Center is helping to modernize engineering education and research by taking full advantage of modern simulation and computing power. One of its objectives is to vertically integrate engineering courses, beginning with freshman courses in engi-

neering design graphics using NX computer-aided design (CAD) capabilities.

NX was implemented for the freshman courses three years ago, replacing another CAD system. To streamline the transition, examples and videos were developed at the UC-Siemens Simulation Technology Center, explaining how to use NX design tools. The center has also begun to guide students in the use of Learning Advantage, Siemens' powerful yet easy-to-use self-paced learning platform that offers an extensive catalog of courses to help students gain skills and knowledge in Siemens Digital Industries Software solutions. "Learning Advantage is great to obtain know-how for various NX design tools," says Parikshit Boregowda, a graduate assistant at the center. "Students can go through Learning Advantage at their own convenience. We also direct students wanting to be certified with NX to take up modules on Learning Advantage."

With NX design skills introduced in the freshman year, students are well-prepared for later-semester courses like solid mechanics, machine design, and finite element analysis, enabling these courses to focus on analysis rather than spending significant time on modeling topics. In addition, many students are offered co-op opportunities at companies that use Siemens solutions.

The implementation of NX in freshman courses has been welcomed by both students and faculty, who appreciate its power and flexibility. "One cannot realize



Simcenter Amesim model developed for lap simulation of the Formula SAE race car.

The college's research centers and labs include the UC-Siemens Simulation Technology Center, established in 2016 as a hub for developing and applying new methodologies and technologies in engineering education and research.

the extent to which input commands are restricted in their flexibility in traditional CAD programs until the command options in NX are experienced," explains John Ucker, adjunct professor at UC. "While this does result in a steeper learning curve, the climb is worth it. The agility with which NX software navigates the seamless blending of multiple-radius fillets is just one example."

Leveraging Siemens solutions in education and student competitions

Simcenter™ Amesim™ software is a 1D systems simulation solution that UC introduced to junior-year students in the Kinematics and Kinetics of Machines course. In this course, students are taught the techniques required to model and analyze dynamic systems found in real-world applications using first principles of kinematics and kinetics of rigid bodies. The students derive equations of motion with hand calculations and are also taught how to model textbook problems using the planar mechanical components libraries of Simcenter Amesim. Students appreciate the ease with which problems can be simulated with the software as opposed to tedious manual calculation, and the animation and plotting tools of Simcenter Amesim provide students with a deeper visual understanding of dynamic behavior.

The software also gives students an advantage in academic competitions, including developing race cars for Formula SAE® events. The University of Cincinnati's Formula SAE team, Bearcats Motorsports, finished 12th in Michigan and 4th in North for the 2018-19 year. To improve on their performance and break into the top 10, the team has adopted new strategies and tools, including lap simulation tools using Simcenter Amesim.

The lap simulator is crucial in the testing phase of developing the car for the competition. After designing and building the car, the team gathers data from different subsystems to confirm reliability and aid understanding of the optimal setup for the actual track in each event in the competition. With the lap simulation tool the car can be simulated running on the actual track layout; the data gathered from the simulation can be used directly to guide crucial decisions.

The vehicle dynamics library of Simcenter Amesim helps refine the digital twin of the car on the track, with prebuilt models of multibody suspensions, tires, powertrains, aerodynamics, and other subsystems integrated with a 15 degree of freedom chassis model to represent the full vehicle. Actual track layouts can be imported and converted to trajectory data files. Sensor

“Simcenter Nastran made teaching Solid Mechanics easier and more interactive. Students can understand how different fundamental principles of mechanics work by visualizing the simulation results on screen, and it also provides them with an additional tool to solve engineering problems.”

Dr. Wei Wang
Professor
University of Cincinnati

blocks and dedicated applications within Simcenter Amesim capture and generate performance data in the simulations.

“We used the pre-built suspension models in Simcenter Amesim to finalize the hard-point locations of our suspension design,” says Alex McIntyre, 2018 suspension team lead for Bearcats Motorsports. “In addition to that, the interactive apps are a convenient way to immediately visualize the effect of changes in the inputs on the characteristic parameters of the suspension. I honestly think Simcenter Amesim will be a part of every Formula SAE team’s toolkit one day.” The UC-Siemens Simulation Technology Center has made the application available in the form of a tutorial video that will enable Formula SAE teams to adopt the simulation technology and perform customized analyses.

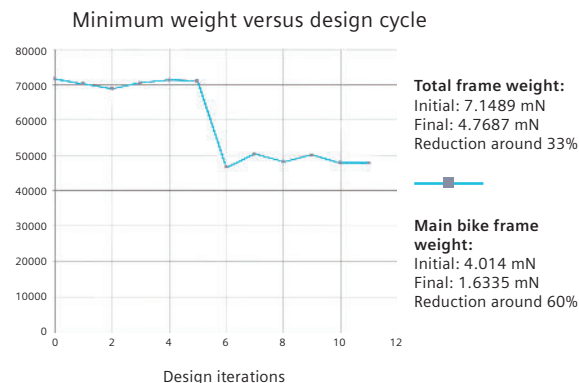
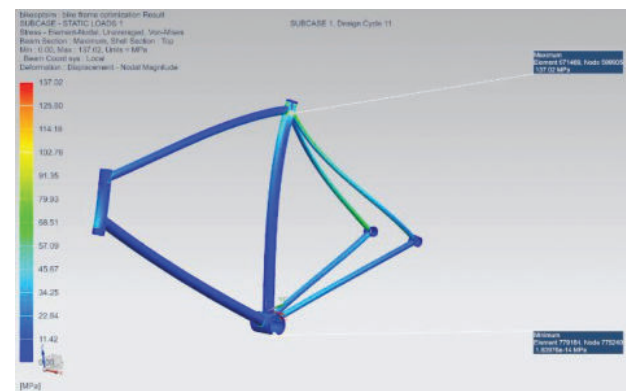
Helping students understand structural behavior

The University of Cincinnati has also introduced leading-edge Siemens simulation solutions into undergraduate and graduate courses in the structural aspects of mechanical engineering. Simcenter™ Nastran® software for finite element modeling and analysis (FEM/FEA) is initially used by sophomore students in the Solid Mechanics course. The course provides an introduction to the software’s interface and instruction on preparing simulation data files, selecting solvers and postprocessing the results to derive useful information.

The use of Simcenter Nastran helps students better understand theoretical concepts that were previously taught using textbooks only. “Simcenter Nastran made teaching Solid Mechanics easier and more interactive,” says Professor Wei Wang. “Students can understand how different fundamental principles of mechanics work by visualizing the simulation results on screen, and it also provides them with an additional tool to solve engineering problems.”

Simcenter Nastran is also used in a junior-year Machine Design course that includes lab problems on deflection and stresses in shafts due to bending and torsion loads. Student gain insights that help in shaft and bearing design. The software is also applied in graduate-level finite element modeling courses that provide in-depth understanding of FEM methodology, including element types, mesh convergence, and analysis types. For final projects, students use Simcenter Nastran to solve their choice of engineering problems.

In one of the lab sessions, the students conducted a stress analysis and weight optimization of a bicycle frame under cruising load conditions, followed by a homework exercise in weight optimization of the bicycle frame under accelerating load conditions.



Empowering students with computational fluid dynamics

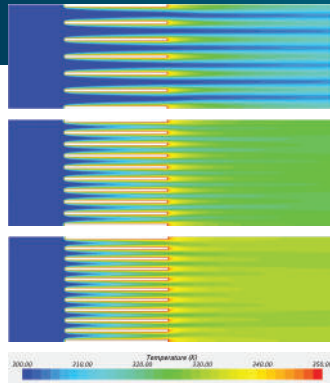
Mechanical engineering undergraduates at UC are required to take Fluid Mechanics and Heat Transfer courses in the fifth and sixth semesters. The Fluid Mechanics course introduces the students to computational fluid dynamics (CFD) simulations with Simcenter™ STAR-CCM+™ software, which they apply to learning the mathematically complex physics of fluids. The software is also used in the Heat Transfer course, in which students are introduced to the principles of heat conduction, forced and natural convection and radiation. In these two courses, students develop simulation capabilities to apply to practical real-world problems, using the results to optimize designs.

Leading-edge research in additive manufacturing

Additive manufacturing (AM) has become a popular choice for building complex parts ranging from large aircraft leading edges to nanoscale tactile sensors. UC's Center for Global Design and Manufacturing is driving innovation in the technology with research focused on formulating and building efficient computational algorithms for error-free, right-first-time additive manufacturing. The research has resulted in the development of software tools that are ahead of the commercial timeline.

UC offers courses on additive manufacturing at undergraduate and graduate levels, including a special course focusing on computational geometric principles, data structures and algorithms for design for additive manufacturing (DFAM) guidelines, taught to seniors and master's degree students. Recently, the university has also offered a Master of Engineering program in additive manufacturing. This course is specifically designed to train students with both the theoretical and practical concepts involved in metal and non-metal based additive manufacturing processes.

UC has collaborated with Siemens to design computational tools for additive

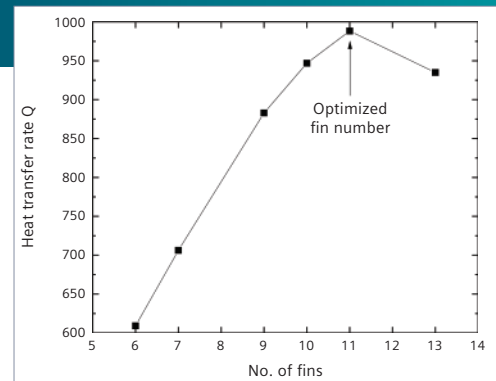


In the Heat Transfer course, students use Simcenter STAR-CCM+ to optimize cooling fins in an electronic device.

manufacturing within the NX software using the NX Open application programming interface (API), implementing all of the algorithms using the C++ programming language. The support provided by the Siemens Global Technical Access Center (GTAC) in developing these tools and guiding the use of NX Open API functions are key factors in the success of this project.

A key goal of the project is to develop a set of tools used to augment CAD geometry or change the build orientation of the part to prevent defects in additive manufacturing. Another goal is to develop and integrate these computational tools within NX software so that students at all levels can use them to gain understanding of design guidelines for additive manufacturing. The tools are very intuitive – high school students as well as Ph.D. researchers can effectively use the tools with the help of detailed instructions, installation manuals and videos that are packaged with the software.

These preprocessing and simulation tools serve as a digital twin that helps designers evaluate and refine part models and attributes of the AM process to prevent problems or failures in the layer-by-layer build process. The tools are seamlessly integrated with the NX software and work directly with NX CAD geometry, so that designers can quickly modify designs to improve AM producibility. A set of support parameter tools helps designers specify and generate CAD models of the support structures that anchor parts in the build



“Learning Advantage is great to obtain know-how for various NX design tools. Students can go through Learning Advantage at their own convenience. We also direct students wanting to be certified with NX to take up modules on Learning Advantage.”

Parikshit Boregowda
Graduate Assistant
University of Cincinnati

Solutions/Services

NX

siemens.com/nx

Simcenter Amesim

siemens.com/simcenter-amesim

Simcenter Nastran

siemens.com/simcenter-nastran

Simcenter STAR-CCM+

siemens.com/simcenter

Customer's primary business

The University of Cincinnati is a premier public urban research university dedicated to undergraduate, graduate, and professional education, experience-based learning, and research. The UC College of Engineering and Applied Science unleashes education by immersing students in a rigorous and innovative curriculum and culture of real-world, experience-based learning. The CEAS has built relationships with more than 1,200 companies. The diverse research facilities provide a challenging environment for students to learn and innovate.

www.uc.edu

Customer location

Cincinnati, Ohio
USA

tray. The tools also check the accessibility of the supports and calculate a producibility index value.

Feature detection tools automatically identify aspects of the CAD model that can compromise build quality, including small openings, thin regions, sharp corners, thin-to-thick transitions, thin walls and collisions with the recoater arm that deposits layers of powdered material in the process.

Build estimation tools calculate build times, cusp errors and other aspects of the build process. Future plans for the DFAM capabilities include implementing the tools in MindSphere, Siemens' IoT operating system, and implementation of Simcenter

Nastran tools for thermal deformation prediction and compensation.

Developing future talent through co-op education

Siemens has also entered into a long-term talent development partnership with UC to employ co-ops on a strategic and programmatic basis. These co-op working students will be placed on important software development programs and related projects in Siemens Digital Industries Software's Milford, Ohio office. This strategic co-op program includes additional training in the business and skill development programs to prepare students for their careers upon graduation.

// We used the pre-built suspension models in Simcenter Amesim to finalize the hardpoint locations of our suspension designs. I honestly think Simcenter Amesim will be a part of every Formula SAE team's toolkit one day."

Alex McIntyre
2018 Suspension Team Lead
Bearcats Motorsports
University of Cincinnati

Siemens Digital Industries Software

Americas 1 800 498 5351
Europe 00 800 70002222
Asia-Pacific 001 800 03061910

For additional numbers, click [here](#).

siemens.com/software

© 2020 Siemens. A list of relevant Siemens trademarks can be found [here](#). Other trademarks belong to their respective owners.
78307-D5 5/20 C