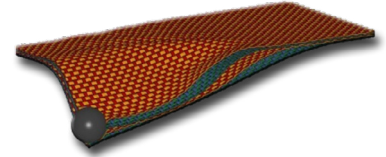


COMPOSITE DESIGN & ANALYSIS CAPABILITIES

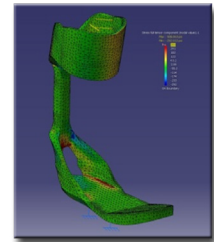
As a world-wide leader in composites science and engineering, CCM provides extensive design and analysis capabilities to our scientists, students, and faculty to conduct advanced simulations supporting our ongoing research programs. This software includes advanced CAD-CAE based applications such as CATIA V5, Pro/E and SolidWorks for mechanical design and product development. Abaqus/CAE, ANSYS, LS-DYNA, MSC MD Nastran/Patran, Marc, and HyperWorks are available for standalone FEA analysis. MATLAB and Mathematica are available for modeling complex multiphysics systems and processes. CATIA CPM and MSC Laminate Modeler are used to conduct draping simulations, flat pattern generation and composite laminate ply books.

Our in-house analytical codes, including CDS3.1 (Composite Design and Simulation), SMARTree 1.6, and LIMS, complement these commercial codes to manage and predict material properties, analyze composite plate and cylinder structures, incorporate experimental results, and conduct flow simulations from existing FEA solutions. CCM has extensive experience in the application of these tools to solve both research and industrial problems. Some examples of applications utilizing these codes include:

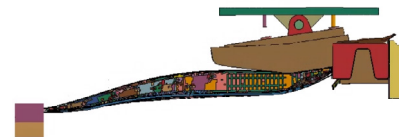
- Design and optimization of a thermoplastic composite B-Pillar for automotive applications with CATIA, Hypermesh and LS-DYNA
- Embedded energy storage and return devices within soldier combat boots using CATIA
- Upper body support structure design and optimization with CATIA
- Dynamic penetration mechanics modeling of dry fabrics and hybrid composite structures using LS-DYNA
- Advanced CFD modeling of flame combustion heating of automated tow placement with ANSYS
- Design and optimization of ankle-foot orthotic structures with CATIA integrate FEA solvers
- Aircraft trailing edge design with MSC SimDesigner
- Evaluation of composite sandwich panels under impact loading using ABAQUS
- Modeling the electrospinning field shape with COMSOL Multiphysics
- Pin bearing stress and failure analysis of thick section composites with AFC
- Breathable membrane stretching with SolidWorks COSMOSXpress
- Discontinuous tile modeling with ANSYS
- Aircraft hat stiffener shape optimization with CATIA, MSC Laminate Modeler and FiberSIM
- Modeling biomimetic structures with ABAQUS
- Radome flat pattern optimization with FiberSIM



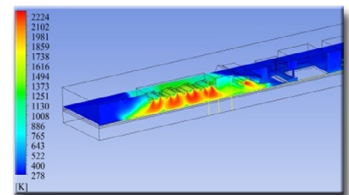
Impact of Flexible woven Fabrics with LS-Dyna



Ankle Foot Orthotic Optimization using CATIA V5



Composite B-Pillar Crash Modeling with LS-Dyna



CFD Modeling of Automated Tape Placement Process using ANSYS



45 YEARS OF INTERNATIONALLY RECOGNIZED EXCELLENCE

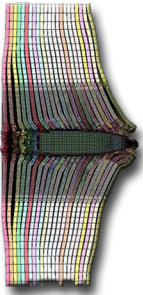
Technical Contacts:

Dan Molligan
302.831.7410 | molligdj@udel.edu

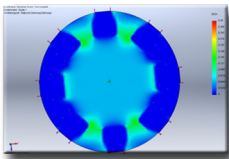
Dr. John Tierney
302.831.0548 | jtierney@udel.edu

101 Academy Street
Newark, DE 19716

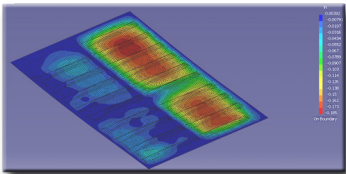
COMPOSITE DESIGN & ANALYSIS CAPABILITIES



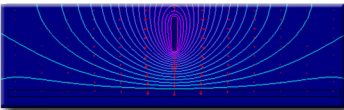
Penetration Modeling with LS-Dyna



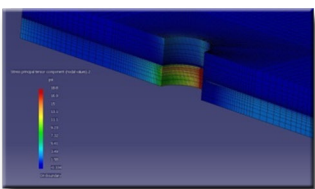
Membrane Stretching with Solidworks



Aircraft Trailing Edge Design with MSC SimDesigner



Modeling the Electrospinning process with COMSOL



Modeling pin bearing stresses with AFC

Composite Design & Manufacturing

Dassault Systems CATIA environment and associated workbenches have been utilized extensively at CCM in the design and analysis of composite structures for basic and applied research. CATIA CPD (Composites Design 3) and CPM (Composites Design for Manufacturing) provides students and research scientists access to process orientated tools dedicated to the design and manufacturing of composite parts. These composite tools provide insight for preliminary and detailed design while assessing requirements for manufacturability. This software has already proven extremely useful in reducing the costs for hand lay-up, RTM, and automated tape laying and fiber placement operations within the industry. It is now incorporated into the CCM design framework to oversee the concept and design phase, but also ply book management, materials handling, equipment systems and plant layout.

Re-Engineering Technology

In addition to our software capabilities, a dedicated re-engineering laboratory is available with ScanWorks scanning software. The re-engineering workcell incorporates several key capabilities that are critical to allowing rapid design of composite replacement components to displace existing metallic designs/components.

This equipment includes a 6-axis arm with laser scanner and software to create surface and 3D solid models through direct digitization of existing geometry. These capabilities include the ability to capture part geometry, either through existing CAD or drawing data or through 3D scanning of components. The 3D scanning technologies are critical, since, in many cases, accurate or detailed drawings or CAD information are not available. These capabilities provide the platform for integration with our analysis capabilities, CNC machining, laser cutting, data management, and other functions required to conduct interdisciplinary research within CCM as well as to interface efficiently with our sponsors.

WORK Cell Technologies

UD-CCM has been able to transition the technology and expertise to our industrial partners through a "workcell technology" approach that enables us to establish an "agile manufacturing enterprise." Specific workcell technologies can be utilized independently as required. The capabilities include reverse engineering and re-engineering, tooling, ply cutting and preforming, process simulation (draping and mold flow), intelligent process control, data collection and on-line quality assurance (QA)/quality control (QC), and ultimately, an intelligent system to link these workcells to allow communication and sharing of data among them.

Technical Contacts:

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