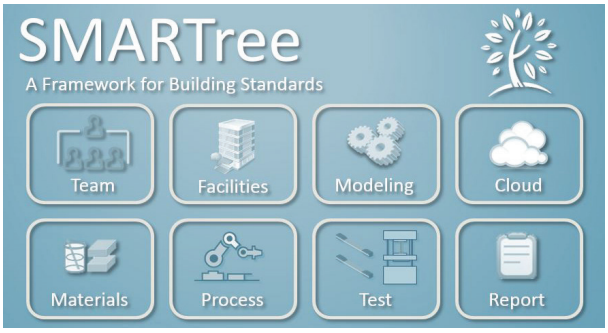
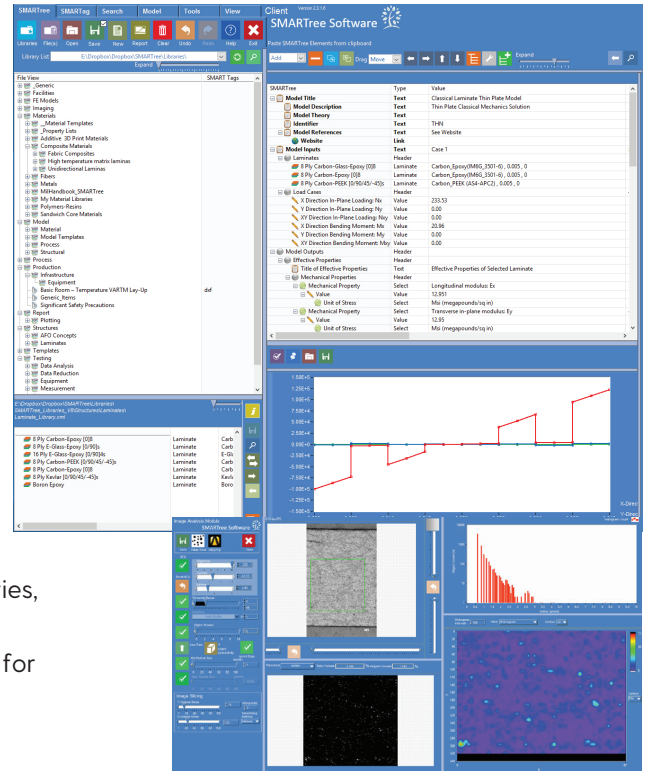
# UNIQUE SOFTWARE CAPABILITIES

CCM has been creating unique design and analysis software solutions for composite structures for more than two decades. The software is continuously upgraded to reflect new research findings as well as to capitalize on advances in computing technology. Software applications such as SMARTree, LIMS and MAT162 are used extensively by researchers at UD-CCM and industrial sponsors to predict material properties and behavior during processing as well as study failure of composites under dynamic loading.

## SMARTree

SMARTree is an easy to use drag and build GUI with built-in solvers that allows implementation and control of standard protocols to store and share material, process and test data. The client manages creation and storage of XML data with built-in data and logic checking that validates the information while being assembled. The software leverages the power of GitHub and GraphQL to access and store data with version control while utilizing 'SMART Tags' locally to hashtag metadata that reference stored tree data for embedded modeling and design functionality. The client can also directly import raw test data and images so that the user not only has access to summary data but also the source material that derived this information. Some features of the software include:




- Easy to use drag and drop GUI that allows implementation and control of standard protocols to store and share material, process and test data.
- Built-in hierarchical logic and integrity checks so as to ensure valid data with compliance to various material and test standards.
- Embedded solvers for micromechanics, laminate mechanics and process modeling of composites.
- Data reduction methods capable of handling various data sources including images and test data.
- GitHub storage and access for redundancy and version control.
- Active folder management utility that tracks SMARTree's within cloud folders.
- Options to build active sensor SMARTrees as well as passive properties, standards and procedure libraries.
- Communicates to external devices using standard NI DAQ protocols for machine process control and feedback.

*www.ccm.udel.edu/software/smartree-software/*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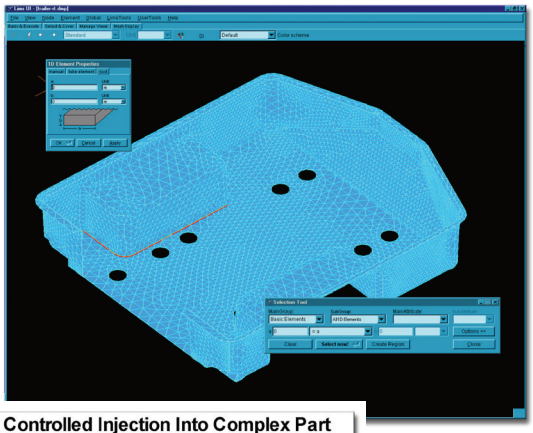
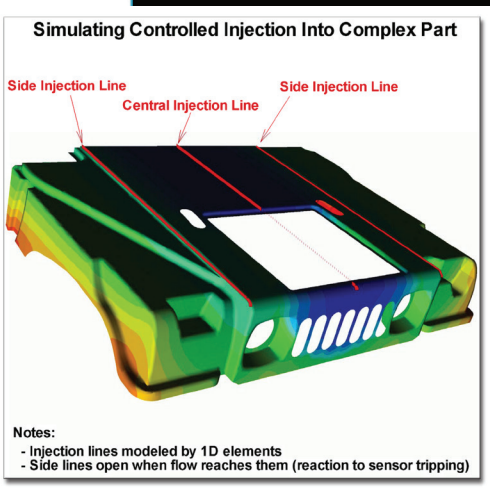
## Liquid Injection Molding Simulation (LIMS)

Liquid Injection Molding Simulation (LIMS) is a software tool that simulates the mold filling stage of resin transfer molding (RTM) and related processes. LIMS has been successfully used to design and simulate intelligent or adaptive filling process that utilizes sensors mounted on the part and controllable injection hardware, either as a stand-alone program or as a simulation engine for other programs.



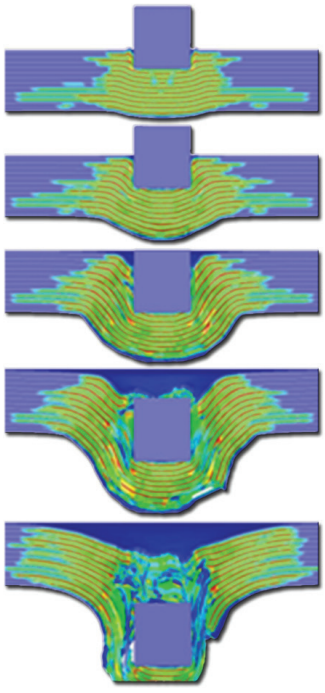
- Fast solution algorithm;
- 3D Solids, 2.5D shells, & 1D runners;
- Multiple injection gates, vents, and sensors;
- Fabric deformation can be integrated.
- Fully adaptable and controllable using script language.
- Dry spot prediction is available.
- Dynamic link libraries are provided for other programs to run and control LIMS simulation and exchange data with the simulation in an efficient manner.
- Graphical user interface tailored toward the specific needs of liquid composite molding is included.
- Input files can be prepared in many applications.

*www.sites.udel.edu/lims/*




## MAT162 in LS-DYNA:
### *Rate Dependent Progressive Damage Modeling of Composites*

MAT162, a material model developed by Materials Sciences Corporation (MSC), is the state-of-the-art in three dimensional progressive damage modeling of unidirectional (UD) and plain weave (PW) composites using solid elements in LS-Dyna, suitable for modeling composites under dynamic impact, penetration, perforation, and blast loading. UD-CCM is the technical support for this material model.



- Quadratic Failure Criteria with a new Delamination Model;
- Rate-Dependent Progressive Damage;
- Tension-Shear Damage Mode allows Modeling Perforation.
- Punch-Shear and Crush Damage Modes allow Modeling Penetration.
- Impact up to 1.5 km/s and blast damage can be modeled.

*www.ccm.udel.edu/software/mat162/*

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