



date: 31 August 2020

to: Michael Skroch (1543) (Programmatic Lead)
Roshan Quadros (1543) (Technical Lead)
Walt Witkowski (1540) and Scott Hutchinson (1350) (Line Deputies)
Corey Cruz (1500) (Line Director)

from: Review Panel: Brett Clark (1543, Chair); Jay Foulk (8363); Jackie Moore (1553); Ron Kensek (1341); Ed Hoffman (8753); Dan Ibanez (1443)

subject: Final Review of FY20 ASC IC L2 Milestone #7181 entitled “Scalable Geometric Modeler for Overlap Detection and Resolution”

The final review for the FY20 Advanced Simulation and Computing (ASC) Integrated Codes (IC) L2 Milestone #7181 was conducted on August 31, 2020 at Sandia National Laboratories in Albuquerque, New Mexico. The review panel unanimously agreed that the milestone has been successfully completed.

Roshan Quadros (1543) led the milestone team and various members from the team presented the results. The review panel was comprised of staff from Sandia National Laboratories Albuquerque and California that are involved with computational engineering modeling and analysis. The panel consisted of experts in the fields of solid modeling, discretization, meshing, simulation workflows, and computational analysis including personnel Brett Clark (1543, Chair); Jay Foulk (8363); Jackie Moore (1553); Ron Kensek (1341); Ed Hoffman (8753); Dan Ibanez (1443). The presentation documented the technical approach of the team and summarized the results with sufficient detail to demonstrate both the value and the completion of the milestone. A separate SAND report was also generated with more detail to supplement the presentation.

The purpose of the milestone was to advance capabilities for automatically finding, displaying, and resolving geometric overlaps in CAD models.

Milestone Overview

The milestone description and completion criteria were established as:

Description: Creating finite element models to simulate NW components currently requires significant investment of computational analyst’s time to resolve what appears as geometry overlap in CAD. Without explicit additional information, this geometry overlap can be interpreted as CAD issues needing to be corrected or could indicate fasteners where preloads are intended. Resolving

modeling issues such as this is essential to the predictivity and credibility of the overall simulation. Resolving this issue is currently a manual process and puts the otherwise insightful scientific (first-principles) modeling and simulation capability un-able to respond to early design phases of a weapon LEP/ALT.

This milestone will develop and put into production a scalable geometric modeler that can automatically identify overlap and patterns of overlap to quickly inform and solicit expert judgement from the user to resolve geometry overlap on ND components/assemblies.

Completion Criteria: With direction from the user (e.g. specifying overlap to be corrected or to be interpreted as an interference fit) the scalable geometric modeler will support the automated meshing algorithm in producing analyzable assemblies for engineering mechanics simulations using the ASC/IC Sierra code suite.

Scope of Review

This milestone was a part of a multi-year effort to develop a scalable geometric modeler that addresses the geometry needs for computational analysis used for design and qualification of ND components and systems. This milestone focused specifically on the geometric modelers ability to identify and provide information for addressing overlaps in CAD models when generating finite element models.

Review Meetings

Over the course of three meetings held at Sandia National Laboratories with remote committee members participating via teleconference, the milestone team demonstrated progress on identifying and resolving overlaps on 3 complex ND example problems: 1) junction box assembly 2) thermal battery assembly and 3) lower housing assembly. An assessment of the developed capability for NW system and component models was made.

The kick-off meeting was held Feb 4, 2020. During this meeting, the milestone team clarified scope and the intent of the milestone for everyone involved. They identified where the new capabilities would be developed, example CAD models that would be used for verification of capabilities, and how they would demonstrate that they met the criteria for the milestone. “Meets” vs. “Exceeds” completion criteria were explained.

A mid-year review meeting was held on April 30 where the milestone team presented progress on the completion criteria. At this point in the year they had completed most of the “meets” criteria related to the geometric modeler capabilities for finding geometry overlaps. The remaining “meets” criteria included finishing some of the Boolean operations in the geometric modeler and then demonstrating the resolution of overlaps using the Morph mesher. At this point they had also finished some of the “exceeds” criteria related to getting a test-bed user interface in place for demonstrating the capabilities. The general consensus of the review panel at this point was that they were on schedule for completing the milestone at the end of the FY.

The closeout meeting was held August 31. This meeting served the purpose of reviewing final results from the milestone work. The team first presented examples of the morph mesher using information about the overlaps from the geometric modeler to generate meshes that resolved the overlaps. This was the final part of the “meets” criteria that was not presented in the mid-year review. Then the team presented examples illustrating completion of the “exceeds” criteria that mainly had to do with the geometric modeler resolving the overlaps in the CAD model rather than relying on the mesher to do it. The team used live demos in the test-bed user interface to demonstrate finding and resolving the overlaps in the 3 verification problems. Part of the milestone was to provide a way for the user to conveniently search for overlaps in a model and then visualize them so that he/she can decide on an appropriate resolution approach. The test-bed user interface that was demoed was very impressive in that it provided some very nice tools for going through this process. As a part of the geometric modeler development a large set of tests was developed to exercise the new code and provide regression testing for future development. The panel was impressed with the rigour that went into the geometric modeler development—an important element given the absolute necessity of correctness in the geometric operations for everything to work properly.

Conclusions

The reviewers concluded that the team met the milestone criteria and successfully completed the milestone. The milestone team provided excellent advancement in the area of resolving overlaps in CAD assemblies and demonstrated in a prototype powerful end-user application of these advancements. The reviewers provided the following comments for incorporation into the final documentation and/or future work as deemed appropriate by the milestone team.

1. Add hyperbolas and parabolas to supported curve types in geometric modeler.
2. Delivery of these advancements to customers is a critical next step. How they are delivered is critical and should include careful thought.
3. One application of these new capabilities that was not focused on in the milestone is to provide feedback upstream of the modeling process to designers to help improve the design process. This could be follow-on work.
4. A clear next step would be to run analyses on the meshes generated with the new capabilities to verify their adequacy for ND calculations.
5. Provide a better user-interface for specifying user intent (priorities) when resolving overlaps. Currently, an input file with all of the volume priorities must be generated and this appeared to be quite tedious.
6. It was suggested that this work for overlap resolution where groups of similar overlaps are recognized and addressed together could be coupled with the machine learning work that is going on to do feature recognition.

Attendees of the August 31st review included:

L2 Milestone Team

Roshan Quadros (PI), 1543
 Matthew Staten, 1543
 Riley Wilson, 1542
 Kevin Copps, 1543

Byron Hanks, 1543
Corey McBride, 1543
Paul Stallings, 1543
Clint Stimpson, 1543

Review Team

Brett Clark, 1543, Chair
Jay Foulk, 8363
Ed Hoffman, 8753
Jackie Moore, 1553
Ron Kensek, 1341

Other

Terri Galpin, Mgr.
Walter Witkowski, Mgr.
Paul Crozier, Mgr.
Kendall Pierson, Mgr.
Michael Skroch, Mgr.
Martin Heinstein
Todd Coffey
Mike Glass
Steve Owen
Scott Mitchell
Trevor Hensley
Salome Thorson
Vicki Porter
Dee Dee Nicole Kerby
Chandler Smith
Allen Robinson
Keith Cartwright
Philip Sakievich
Tim Shelton
Nathan Crane
Martin Crawford
Jeff Crowell
David Day
Clark Dohrmann
Warren Hunt
Richard Drake
Paul Wolfenbarger
Brian Zinser
Timothy Fuller
Justin Lamb
Kevin Manktelow
Jeffrey Mauldin
Michael Neilsen
Jesse Thomas
Timothy Thomas

Benjamin Treweek
Susie Trujillo-Martinez
Dan Turner
Vincente Pericoli
Chris Hammetter
James Willenbring
John Niederhaus
Salvatore Campione