NASA Software of the Year, GENOA-PFA, Given 2000 R&D 100 Award

GENOA-PFA, marketed currently by Alpha Star Corporation, is an enhanced commercial version of the Composite Durability Structural Analysis (CODSTRAN) computer program that was originally developed in-house at NASA Glenn Research Center specifically for polymer-matrix composite structures. Alpha Star Corporation and the University of Clarkson have made substantial developments to the code under the NASA Small Business Innovation Research and University Grant support. The code won the NASA Software of the year award in 1999 and was given the 2000 R&D 100 Award. The current GENOA-PFA can simulate the initiation and progression of damage, ultimately leading to global fracture in advanced composite structures under various loading and environmental conditions. It offers a number of capabilities beyond those of programs developed previously for similar purposes; these capabilities make GENOA-PFA preferable for use in analyzing the durability and damage tolerance of complex aero and space structures that have fiber reinforcements formed as two- and even three-dimensional weaves and braids.

GENOA-PFA implements a progressive-fracture methodology, the basic concept of which is that a structure fails when flaws that may initially be small (even microscopic) grow and/or coalesce to a critical dimension such that the structure no longer has an adequate safety margin to avoid catastrophic global fracture. Damage is considered to progress throughfive stages:

1. Initiation
2. Growth
3. Accumulation (coalescence of propagating flaws)
4. Stable propagation (up to a critical dimension)
5. Unstable or very rapid propagation (beyond the critical dimension) to catastrophic failure.

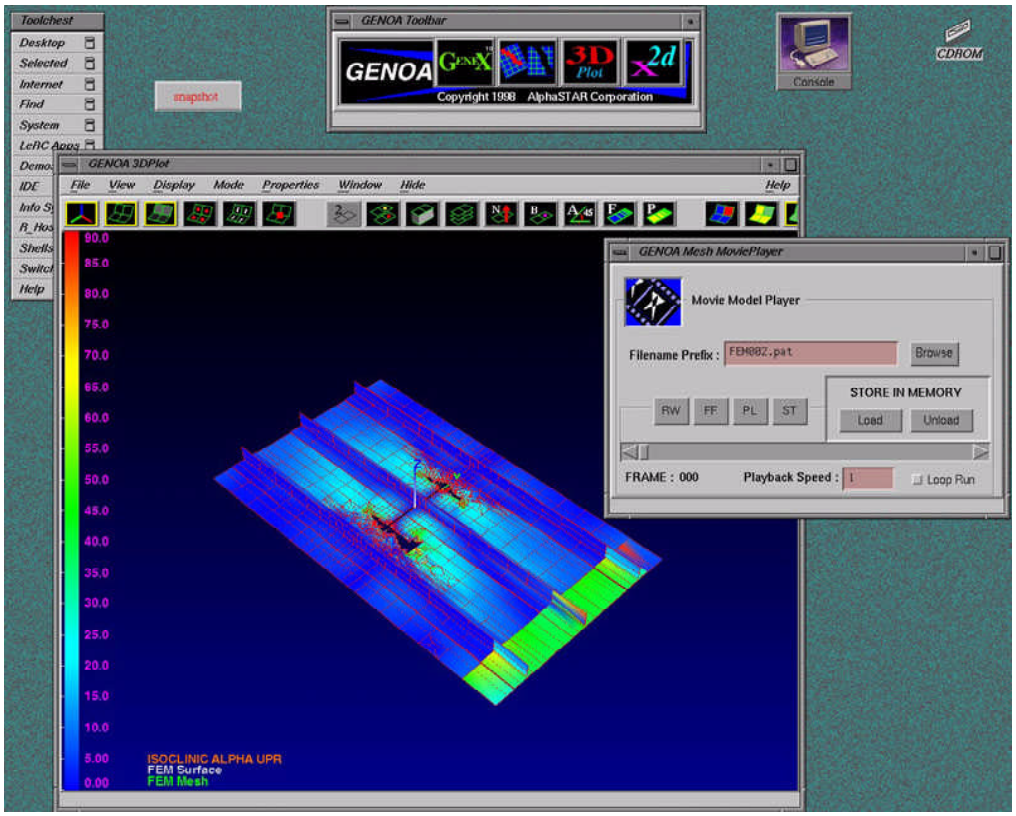
The computational simulation of progressive failure involves formal procedures for identifying the five different stages of damage at each stage and relating the amount of damage at each stage to the overall behavior of the deteriorating structure. Typical applications of GENOA are shown in the accompanying figures.

Some of the salient features of GENOA-PFA software follow:

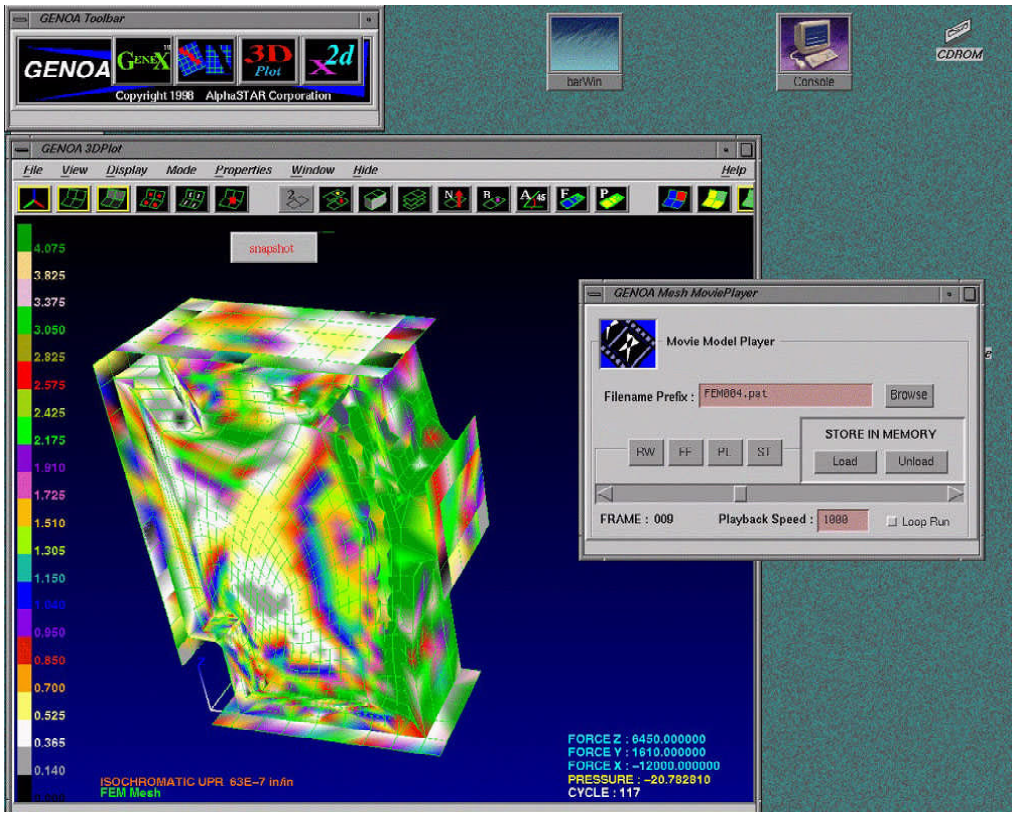
- Inclusion of material nonlinearities through the periodic updating of stiffnesses and inclusion of geometric nonlinearities through Lagrangian updating
- Simulation of the initiation, growth, and ultimate failure of a material under static, cyclic, creep, and impact loads

- Identification of the fractional contributions of various possible composite failure modes involved in critical damage events
- Determination of the sensitivities of failure modes to such design parameters as fiber volume fractions, ply thicknesses, fiber orientations, and thicknesses of adhesive bonds

Over 20 customers from industry, academia, and Government agencies nationwide utilize GENOA for the durability and life analysis of advanced composite structures. Some of the selected industry users are Boeing, Rockwell Aerospace, AlliedSignal, and McDonnell Douglas. University users include Case Western Reserve University, Clarkson University, and the University of California at Santa Barbara. Government agency users include NASA and Wright-Patterson Air Force Base.



GENOA-PFA graphical user interface showing a simulation of composite damage and fracture propagation via CODSTRAN. Act 3 stringer composite wing panel.



GENOA-PFA graphical user interface showing a simulation of composite damage and fracture propagation via CODSTRAN. Airborne laser reactor housing.

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Glenn contacts: Dr. Pappu L.N. Murthy, 216-433-3332, Pappu.L.Murthy@grc.nasa.gov; and Dr. Christos C. Chamis, 216-433-3252, Christos.C.Chamis@grc.nasa.gov

Author: Dr. Pappu L.N. Murthy

Headquarters program office: OAT

Programs/Projects: Base R&T

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