# DARWIN® 7.2 Release Notes

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Southwest Research Institute®

## Summary of New Capabilities

DARWIN 7.2 includes the following new features:

- Automatic Zone Generation
- Time-Dependent Fatigue Crack Growth Assessment
- Parallel Processing
- Residual Stress Profiles
- FE2NEU Support for ABAQUS Models with Non-Cartesian Coordinate Systems
- Mission Definition Enhancements

## Automatic Zone Generation

DARWIN 7.2 includes an initial capability for automatic generation of zones for risk assessment of engine components containing inherent material anomalies. The user interface was enhanced to enable the analyst to assign component properties (e.g., anomaly distributions, material properties, inspection schedules) directly to finite elements rather than zones (see Figure 1). Once the properties are assigned, DARWIN automatically generates a zone at each finite element in the user-supplied FE model. The orientation and boundaries of the fracture model are then computed using the automatic geometry model process introduced in DARWIN 7.0.

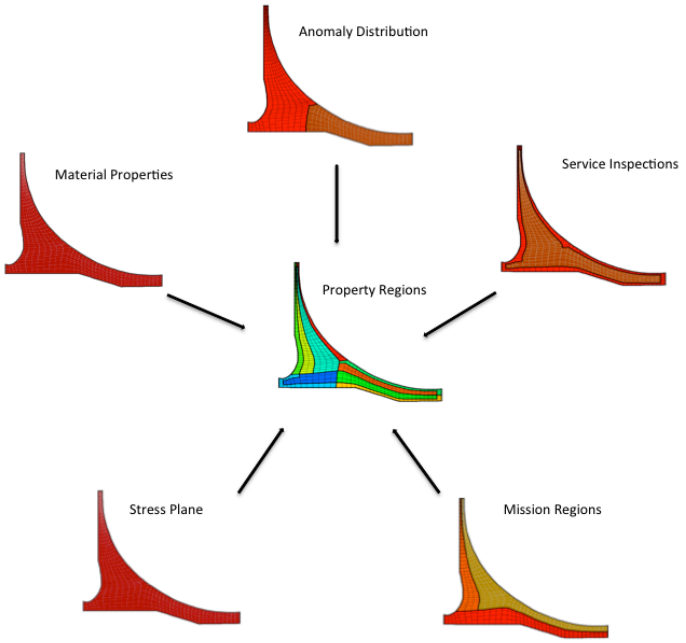


**Figure 1: DARWIN 7.2 includes an initial capability for automatic generation of zones for risk assessment of engine components containing inherent material anomalies.**

The finite element-centric assignment of component properties associated with this feature can also be applied to manual creation of zones. Once the properties are assigned by the user, DARWIN identifies regions with identical properties that can be directly converted into zones. Note that the user also has the option to use the zone editor for zone creation as in previous versions.

This new capability significantly reduces the amount of human time and judgment required for risk assessment of gas turbine engine components. Enhancements to this capability are planned for future DARWIN versions that will increase the computational efficiency of the zoning process by combining adjacent zones with similar properties.

## Time-Dependent Fatigue Crack Growth Assessment

DARWIN 7.2 includes an initial capability for time-dependent fatigue crack growth assessment. This capability is especially important for components exposed to higher temperatures and longer mission times. The user provides material properties for time-dependent crack growth via a new section of the DARWIN material data file. These properties can be viewed in the GUI as shown in Figure 2. The Mission Editor was enhanced to allow the user to provide the elapsed time associated with each load step of the flight history (see Figure 3). The crack growth life is then computed using a superposition of the cycle-dependent and time-dependent crack growth rates. Overload retardation models applicable to both cyclic and static crack growth will be implemented in future versions.

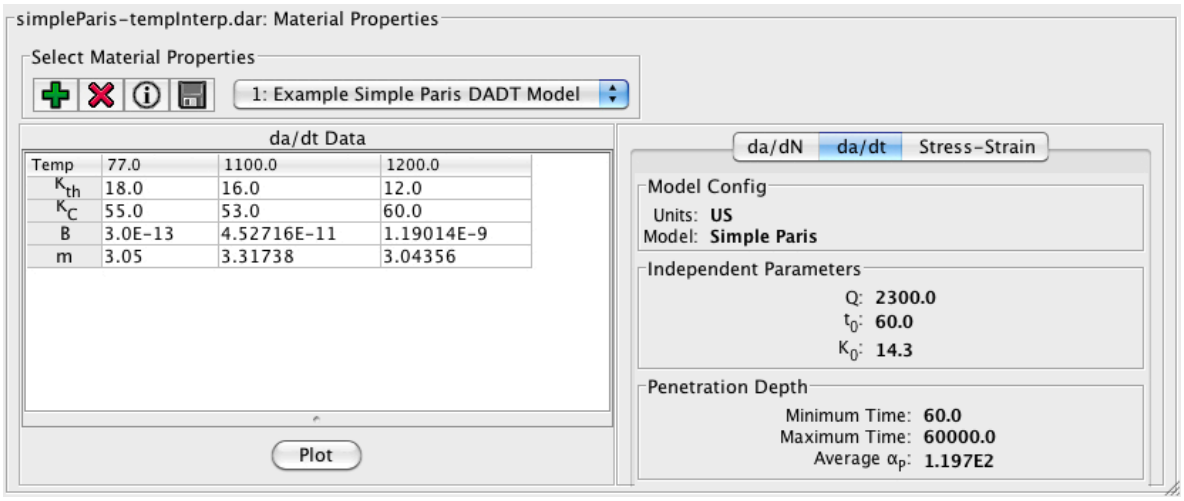


**Figure 2: DARWIN 7.2 includes an initial capability for time-dependent fatigue crack growth assessment, including GUI display of user-specified da/dt material data.**

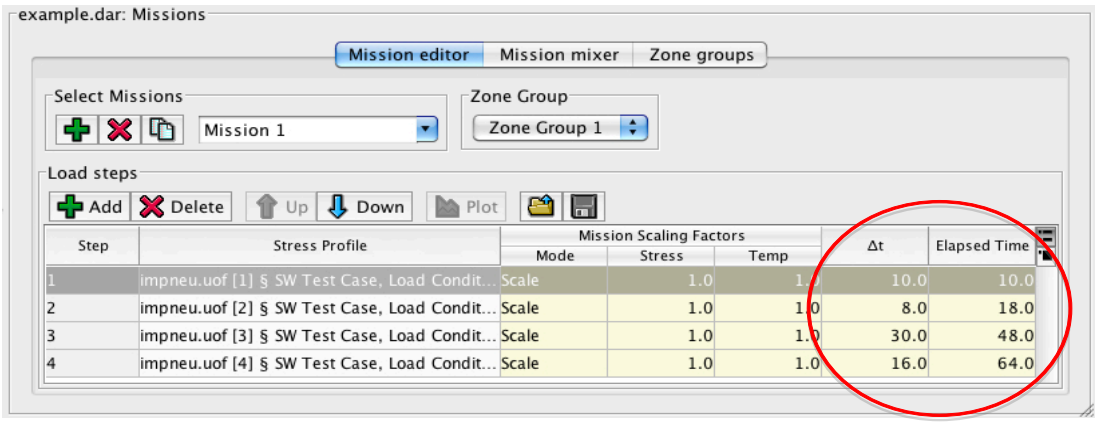


**Figure 3: The GUI was enhanced to provide user specification of the elapsed time associated with individual load steps for application to the time-dependent fatigue crack growth assessment capability.**

## Parallel Processing

Computational efficiency is a critical aspect when performing risk assessment of engine disks where millions of numerical simulations are often required to satisfy computational accuracy requirements. To address this issue, a new parallel processing capability was introduced in DARWIN 7.2 that automatically subdivides the risk computation for simultaneous application to multiple CPUs on a single computer. The GUI includes a new feature to allow the analyst to specify the number of CPUs to be allocated for DARWIN computations (see Figure 4). The new parallel processing capability can substantially reduce the computation time required for risk assessment of gas turbine engine components, as shown in Figure 5.

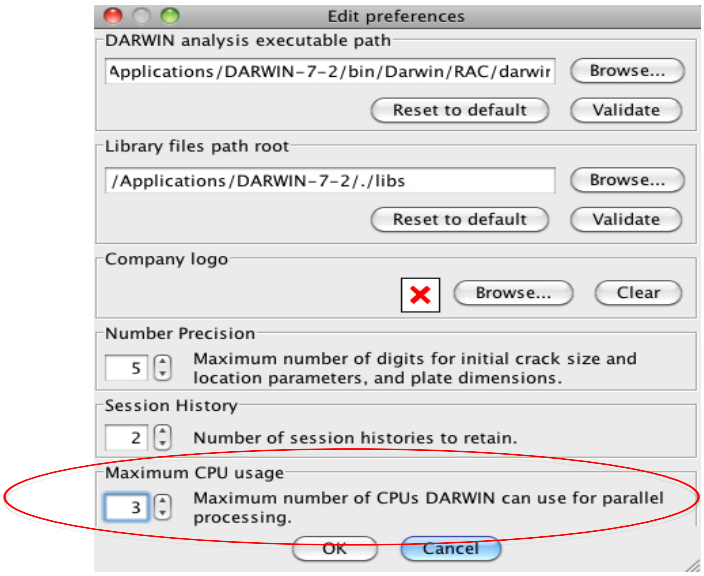


**Figure 4: A new parallel processing capability was introduced in DARWIN 7.2 that substantially reduces the computation time required for risk assessment of gas turbine engine components.**

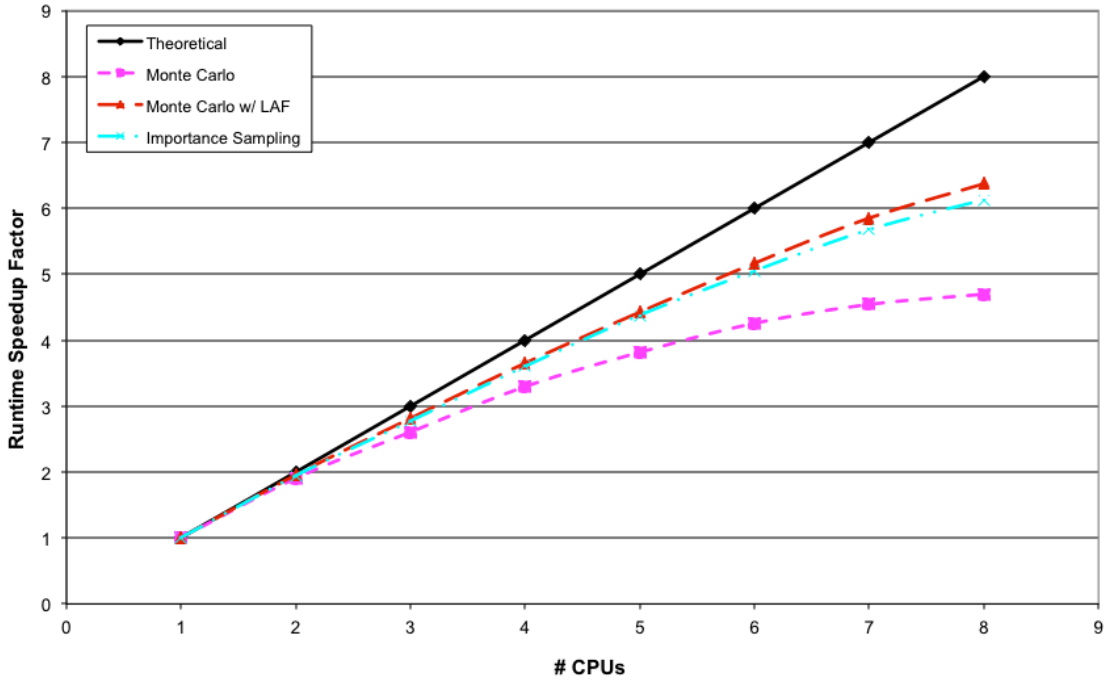


**Figure 5: The new parallel processing capability can substantially reduce the computation time required for risk assessment of gas turbine engine components.**

## Residual Stress Profiles

A new feature is available in DARWIN 7.2 for modeling residual stresses associated with surface treatments applications (e.g., shot peening). Residual stress profiles can be applied directly to 2D finite element models (Figure 6). The user can define and view residual stress profiles directly in the GUI (Figure 7). The residual stresses are combined with service stresses for crack growth life and risk assessment using superposition.

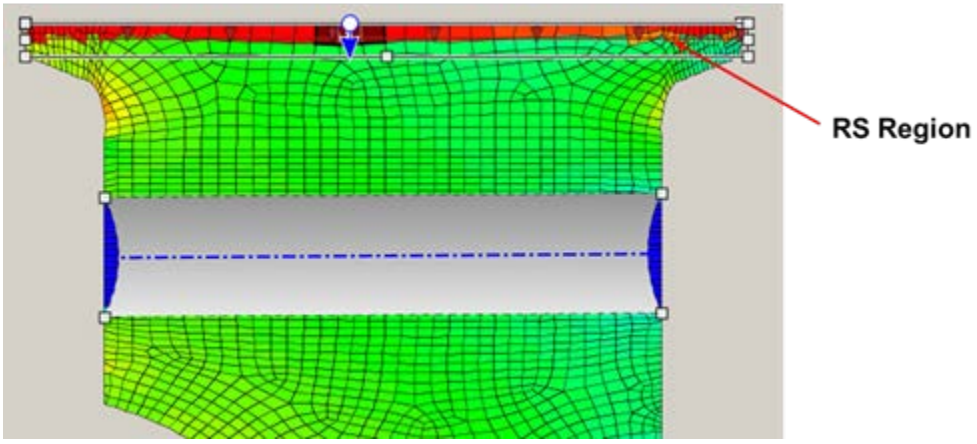


**Figure 6: The residual stress profile feature enables users to apply residual stress fields directly to a 2D finite element model.**

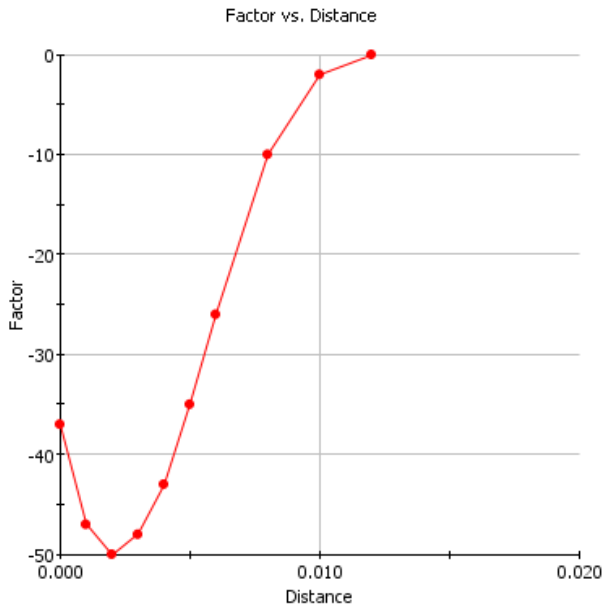


**Figure 7: The user can define and view residual stress profiles directly in the GUI.**

## FE2NEU Support for ABAQUS Models with Non-Cartesian Coordinate Systems

DARWIN 7.2 includes an enhanced version of the FE2NEU finite element model conversion tool that supports conversion of ABAQUS result database files with non-Cartesian coordinate systems (e.g., cylindrical coordinate systems) to the SIESTA neutral file format associated with DARWIN.

## Mission Definition Enhancements

The mission definition setup has been enhanced in DARWIN 7.2 as follows:

- A new ***load step collapse*** feature enables the user to combine load steps associated with different UOF files into a single group. Previously, load steps could only be grouped with load steps from the same UOF file.
- The existing ***load step deletion*** feature enables the user to select and delete multiple load steps at once. Previously, load steps could only be deleted one at a time.

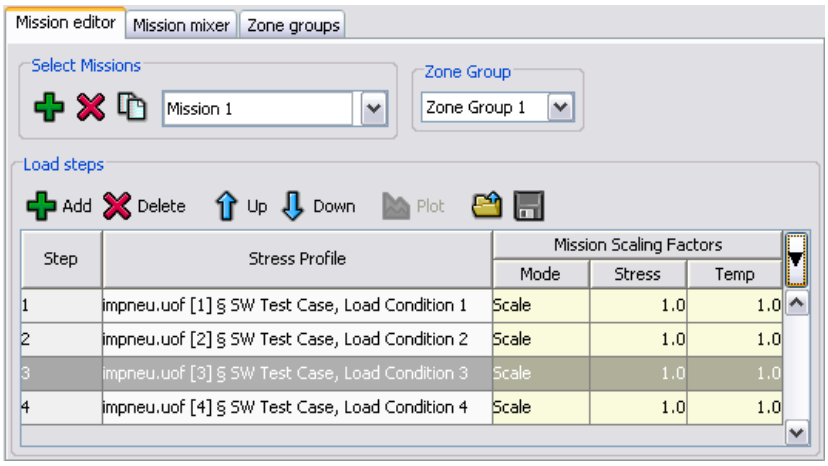


**Figure 8: Mission definition enhancements include capabilities to collapse all profiles into a single group and delete multiple load steps simultaneously.**