DARWIN 4.0 Release Notes

August 2002
Southwest Research Institute

Enhancements

The DARWIN 4.0 release includes several enhancements and new features:
- Initial version for surface damage
- New surface and corner crack solutions for features with holes
- New GUI and risk assessment code capabilities allow user to directly define zones and associated stress information for surface damage analysis
- Includes capability to process length/depth –based defect curves
- Includes capability to process length/depth –based POD curves

Flight_Life Fatigue Crack Growth Code

Additional Solution Methods

The user now has the choice between POLYNOMIAL and WEIGHT FUNCTION solutions for inherent (hard alpha) defects for surface and embedded cracks
- The polynomial solutions are fast (typically 2 to 3 times faster than weight function)
- The weight function solutions are more accurate for complex stress gradients.

The user can chose this option on a per-zone basis in the Zone Editor screen. The corner-crack solution CC01 remains unchanged (linear stress only: axial + bending)
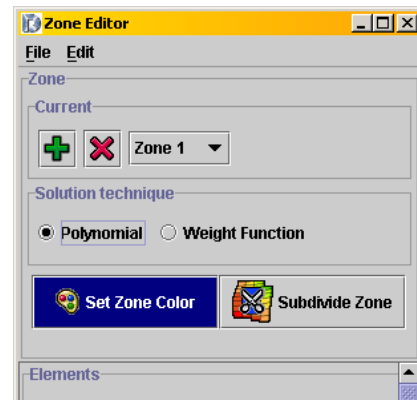

New SIF solutions

- Improved polynomial and new weight function K solutions for surface crack in a plate under uni-variant stress gradient (SC02)
- Improved polynomial and new weight function K solutions for embedded crack in a plate under uni-variant stress gradient (EC02). EC03 is not user selectable and is purely an internal designation, including *a/c* values greater than 1
- New weight function K solutions for corner, (centered) surface, and centered through crack at a round hole in a large plate (uni-variant stress gradient normal to the hole centerline)
- Crack transitioning capabilities for corner or central surface cracks at holes transitioning to a through crack at a hole

Risk Assessment Code

Surface Damage Module

A new surface damage navigation tree appears when the surface damage analysis mode is selected in the main Setup screen. The surface damage navigation tree replaces the stress and zones navigation tree associated with the inherent analysis mode. This allows the user to specify zone and stress gradient information via tabular input.
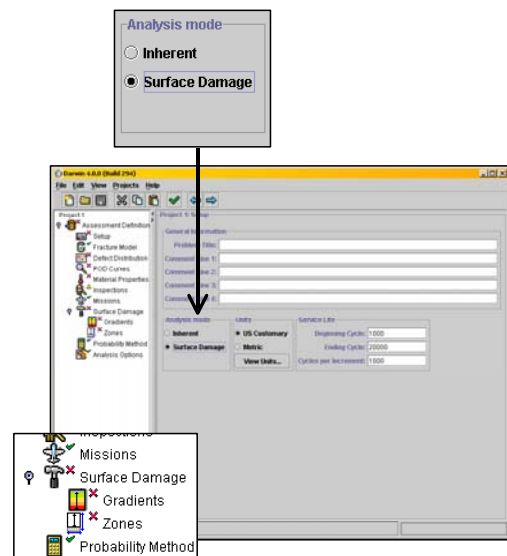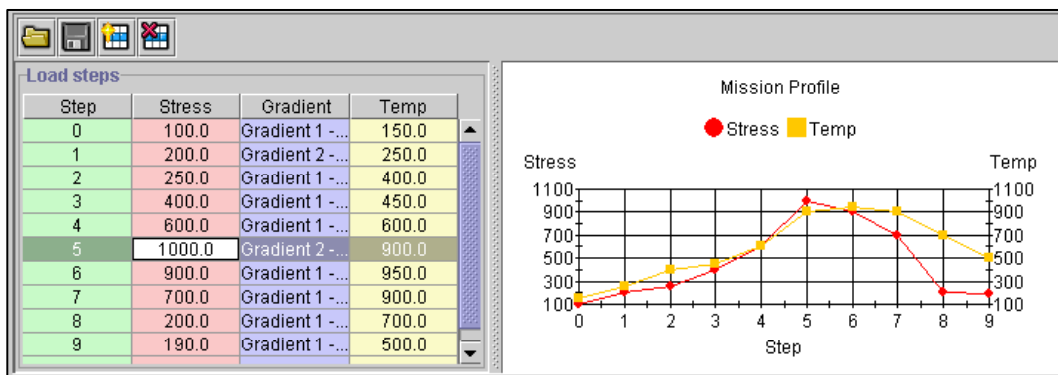
Zone Definition for Surface Damage Problems

A summary of zone definition for surface damage problems is shown below. In contrast with the inherent (hard-alpha) analysis mode (where zones are defined as a collection of finite elements), zones are defined for each individual feature (e.g., bolt hole).
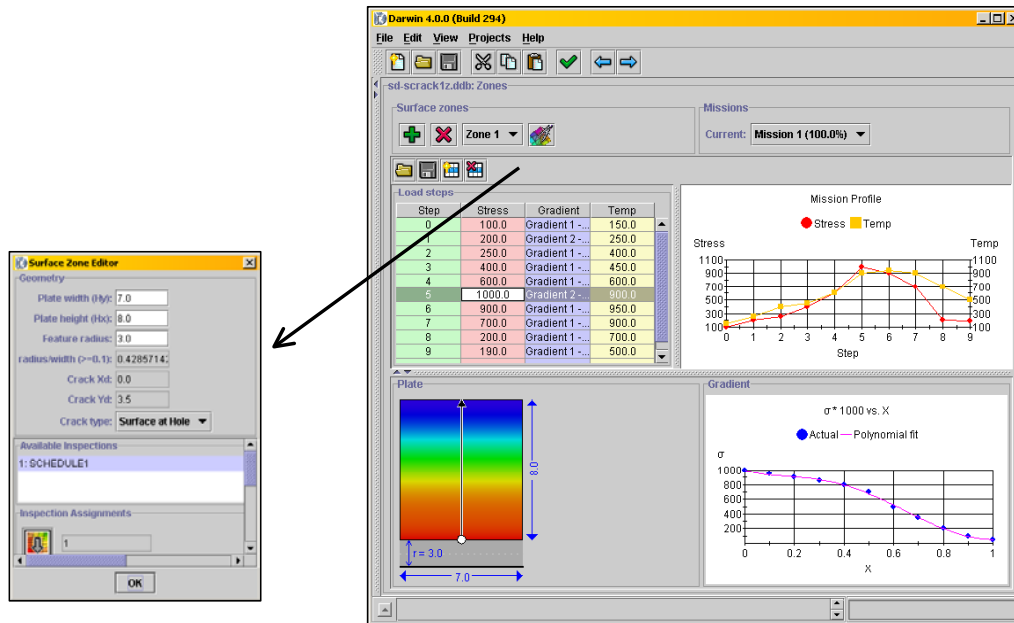
Zones are defined using a new surface Zone Editor (similar to the zone editor in the inherent analysis mode). The user can choose one of three different crack types [surface crack, surface crack (centered) at hole, corner crack at hole]. All of these crack types use weight function K solutions. Using the new features in the surface zone editor, the user can define the dimensions of the plate and associated hole. In addition, the user can define the material, defect distribution, and inspections using this editor window. Similar to the volume multiplier (used in the inherent analysis mode), a feature multiplier is used to define multiple zones that have similar characteristics.
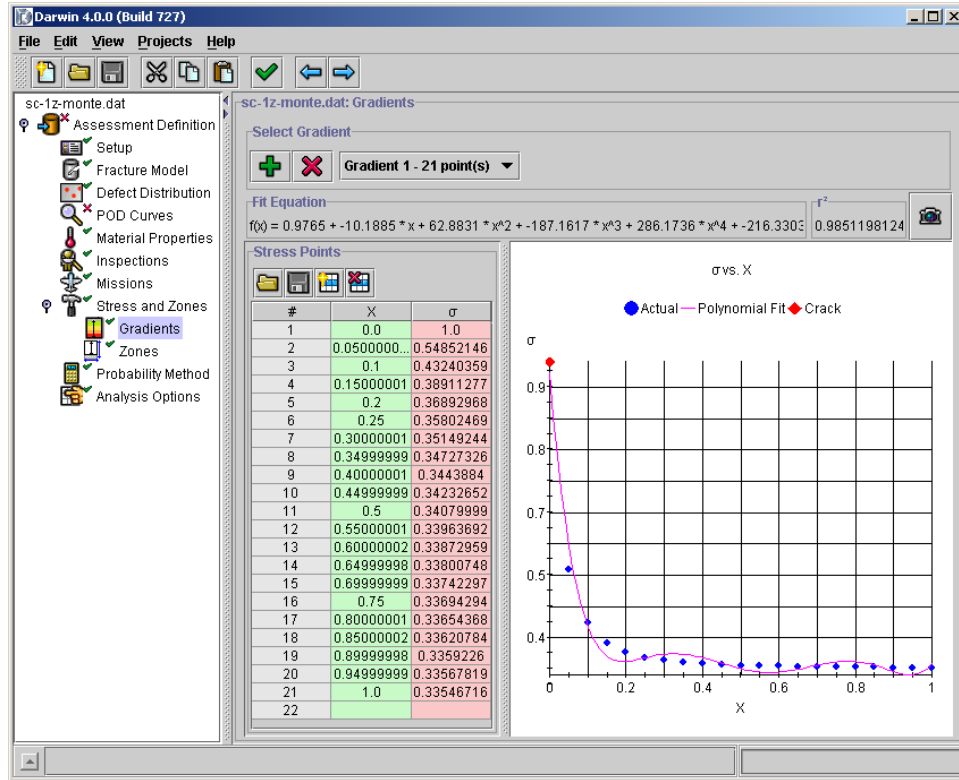
Mission Definition for Surface Problems

In contrast with the inherent analysis mode, the mission information (stress, gradient and temperature) is entered into a load step table directly by the user (shown below). The manually entered load step data can be saved to a file for future analysis. (Note: currently, the analysis is limited to a single stress gradient per zone).

Stress Gradient Definition for Surface Damage

The stress gradient for each zone is defined directly by the user via tabular data entry (see below). The capability for applying normalizing values to the data is provided so that the user can convert raw data (e.g., imported from a finite element model) to the DARWIN™ input format. A plot of stress versus position is provided, including a polynomial fit of the data. The user can adjust the gradient points and export to a data file for future reference. The risk assessment code will process the stress values in this new format.

Darwin 4.0.0 (Build 727)

File   Edit   View   Projects   Help

sc-1z-monte.dat

- Assessment Definition
  - Setup
  - Fracture Model
  - Defect Distribution
  - POD Curves
  - Material Properties
  - Inspections
  - Missions
  - Stress and Zones
    - Gradients
    - Zones
  - Probability Method
  - Analysis Options

sc-1z-monte.dat: Gradients

Select Gradient — Gradient 1 - 21 point(s)

Fit Equation

$f(x) = 0.9765 + -10.1885 * x + 62.8831 * x^2 + -187.1617 * x^3 + 286.1736 * x^4 + -216.3303$ r^2 0.9851198124

Stress Points

| #	X	σ
1	0.0	1.0
2	0.0500000...	0.54852146
3	0.1	0.43240359
4	0.15000001	0.38911277
5	0.2	0.36892968
6	0.25	0.35802469
7	0.30000001	0.35149244
8	0.34999999	0.34727326
9	0.40000001	0.3443884
10	0.44999999	0.34232652
11	0.5	0.34079999
12	0.55000001	0.33963692
13	0.60000002	0.33872959
14	0.64999998	0.33800748
15	0.69999999	0.33742297
16	0.75	0.33694294
17	0.80000001	0.33654368
18	0.85000002	0.33620784
19	0.89999998	0.3359226
20	0.94999999	0.33567819
21	1.0	0.33546716
22		

σ vs. X

● Actual — Polynomial Fit ◆ Crack

Length/Depth based defect curves

In DARWIN™ 3.5, the defect distribution curve is limited to defect area only. DARWIN 4.0 was enhanced to allow specification of the defect distribution curve in terms of crack area, length, or depth.

Length/Depth based POD curves

In DARWIN™ 3.5, the Probability of Detection (POD) curve is limited to defect area only. DARWIN 4.0 was enhanced to allow specification of the POD curve in terms of crack area, length, or depth. For inspection, surface cracks can be based on the length or depth of the crack (in addition to area).
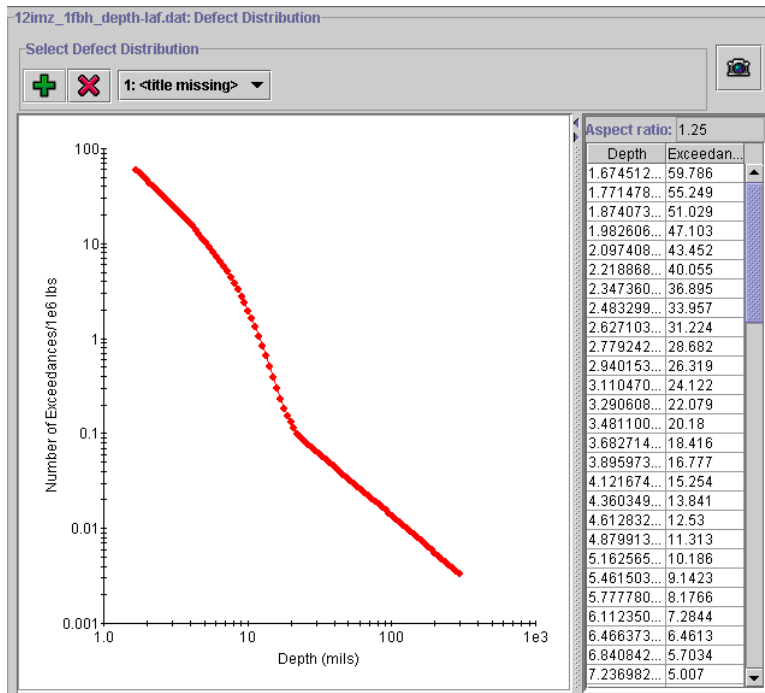
GUI Developments

Mission Mixing

An initial framework for specifying mission mixing parameters was included in the 4.0 GUI. User input for this section of the GUI has been deactivated (mission mixing is currently under development). However, these enhancements provide an initial framework for future mission mixing capabilities.
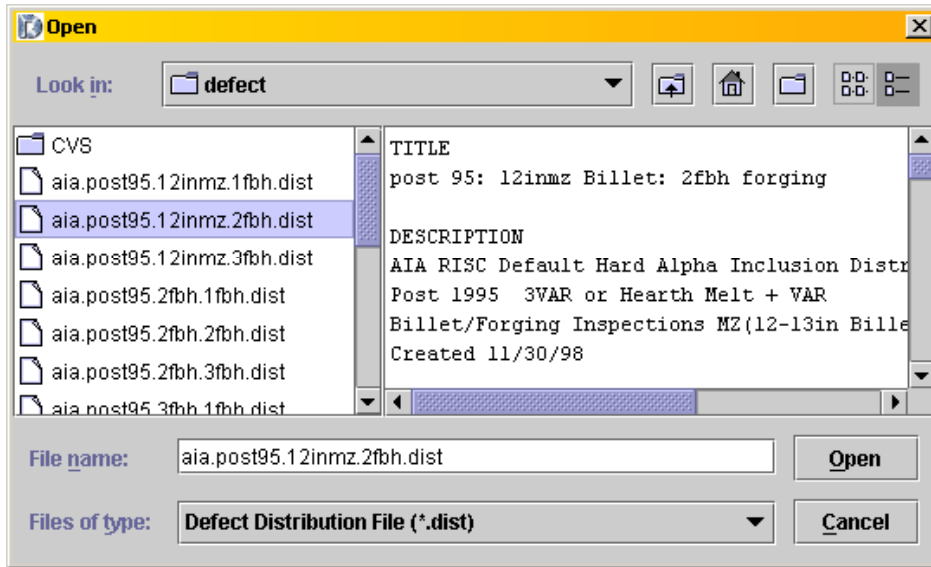
Plate Visualization

Gradient of the selected load step is displayed in both the plate contours and a gradient plot The plate is filled with color gradient mapped directly from polynomial fit of gradient points.
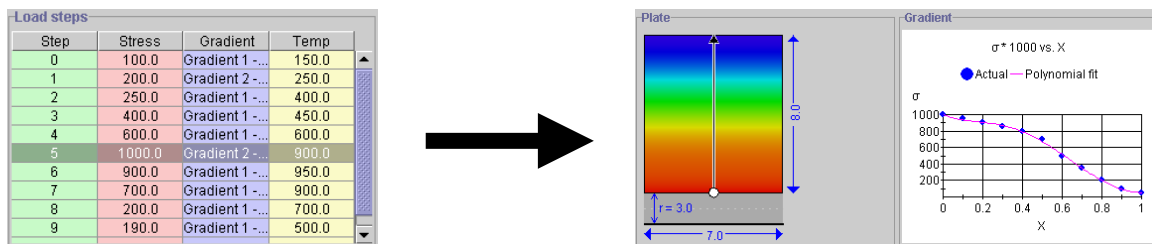
File Preview Screen

The 4.0 GUI provides a complete preview of data files that may be imported during the model definition. Defect distribution, POD curve, and material properties data can be previewed using this new feature.

Open

Look in: 📁 defect ▾ ⬆ 🏠 📁 ▣ ▤

📁 CVS
📄 aia.post95.12inmz.1fbh.dist
📄 aia.post95.12inmz.2fbh.dist
📄 aia.post95.12inmz.3fbh.dist
📄 aia.post95.2fbh.1fbh.dist
📄 aia.post95.2fbh.2fbh.dist
📄 aia.post95.2fbh.3fbh.dist
📄 aia.post95.3fbh.1fbh.dist

```
TITLE
post 95: 12inmz Billet: 2fbh forging

DESCRIPTION
AIA RISC Default Hard Alpha Inclusion Distr
Post 1995  3VAR or Hearth Melt + VAR
Billet/Forging Inspections MZ(12-13in Bille
Created 11/30/98
```

File name: aia.post95.12inmz.2fbh.dist   **Open**

Files of type: Defect Distribution File (*.dist) ▾   **Cancel**

Export of GUI Plots to JPEG Files

The 4.0 GUI includes a capability to save a plot image to a JPEG file. This capability is accessed via a new icon that appears above the plot image, and the user can adjust the image size.
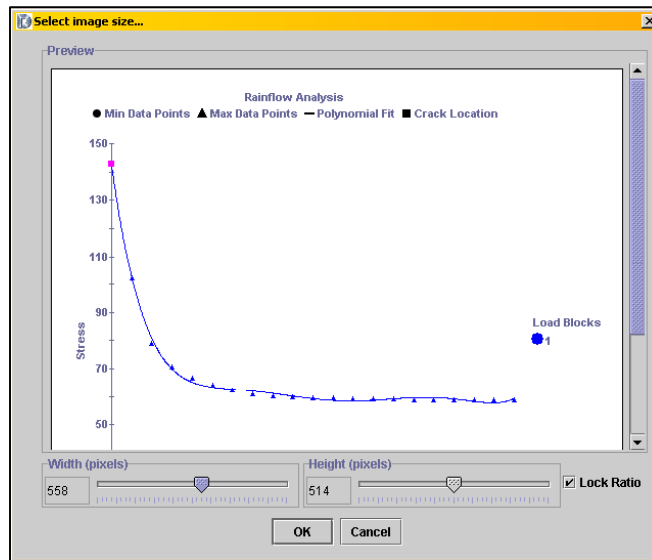
<u>List of Known Bugs</u>

HP Platform

None.

SGI Platform

Array allocation error may occur when using restart feature.

SUN Platform

None.