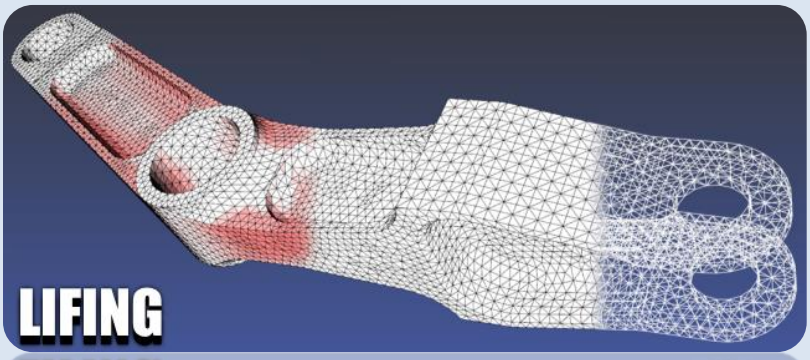



**LIFING** is a program for calculating Fatigue and Damage Tolerance in FE modelled (NASTRAN, OPTISTRUT, ANSYS, ABAQUS and CALCULIX interfaces included) structures subjected to variable amplitude sequence of loads. It calculates both Crack Nucleation (Multiaxial Fatigue, Proportional and Non-Proportional Loadings) and Crack Growth (included FEM automatic remesher).

## FATIGUE - CRACK NUCLEATION

Fatigue Life, i.e. crack initiation, is calculated throughout the entire FEM or at user defined locations. Life, critical location (where initial crack will nucleate) and crack orientation are calculated.

FEM stresses are automatically surface resolved, then, based on given material properties and gives spectrum of loads, fatigue life is calculated.

Multiaxial Fatigue Strain based approaches are implemented:

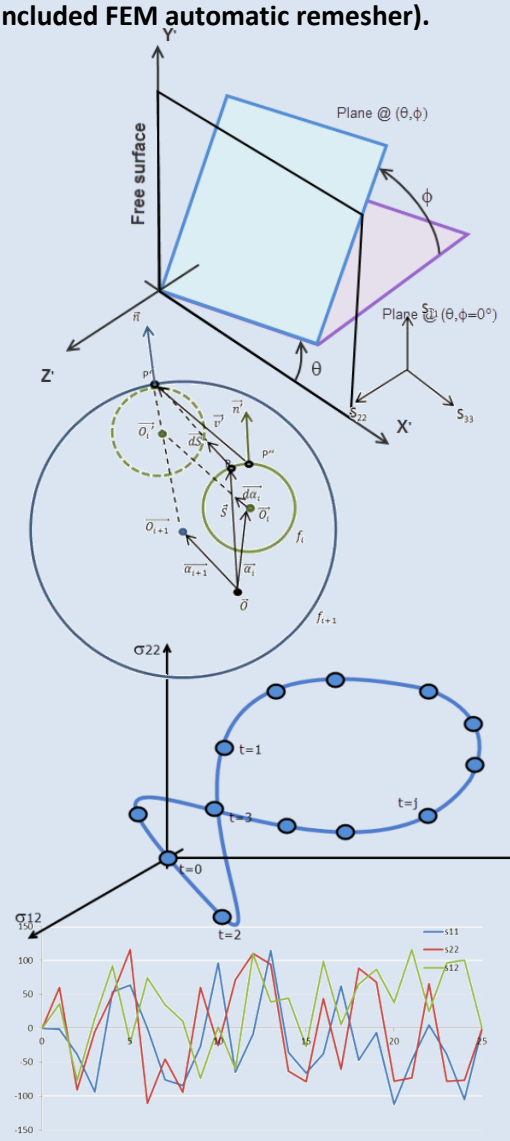
- Equivalent Stress and Critical Plane methods
- Neuber or Glinka E.S.E.D. methods for calculating plastic stress-strains
- Hoffmann-Seeger or Dowling equivalent stress approach (for Proportional loadings)
- Pseudo Material approach (with Mroz-Garud multi-surface cyclic plasticity method)
- Smith-Watson-Topper, Morrow's, Manson-Halford, Brown-Miller and Fatemi-Socie parameters

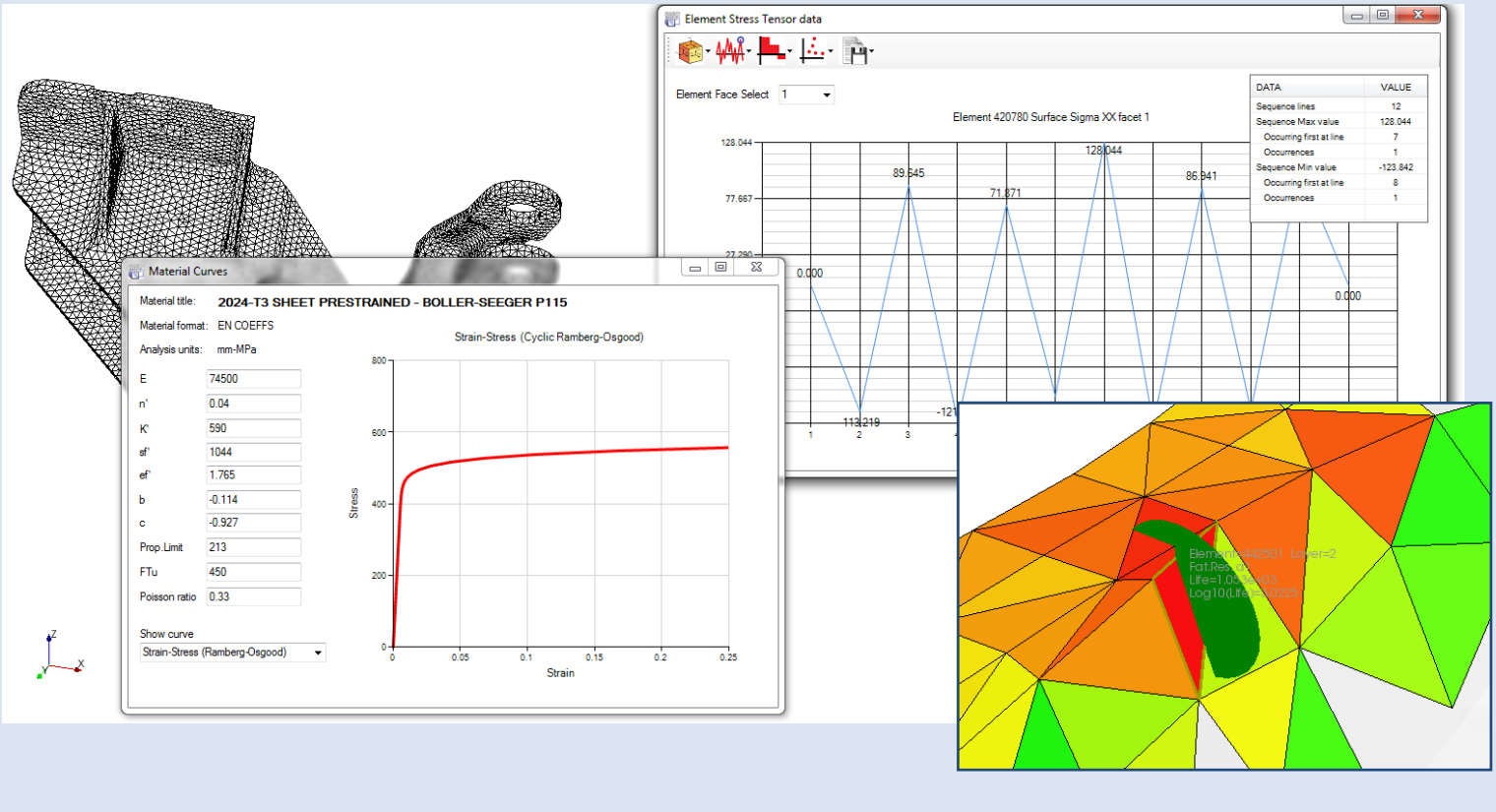
Multiaxial Fatigue Stress based approaches are implemented:

- Equivalent Stress methods
- Dang-Van, McDiarmid

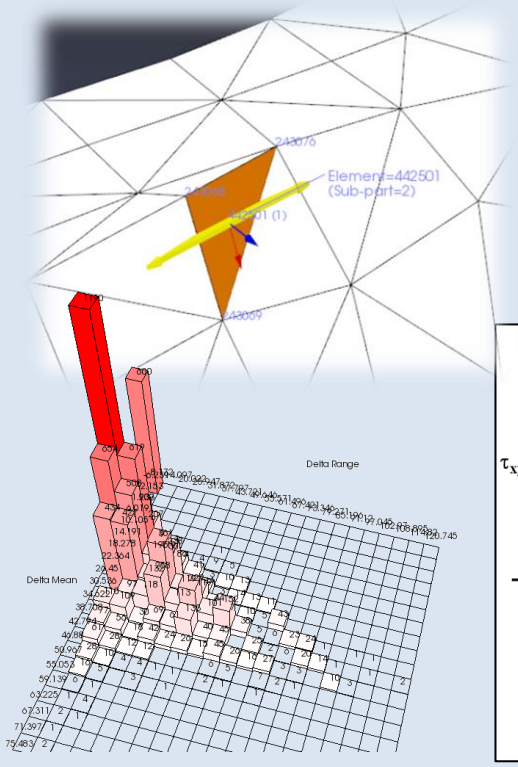
Conventional uniaxial methods for S-N curves (Goodman, Gerber, Soderberg, Walker, Smith-Watson-Topper, Haigh, MIL-HDBK-5J curves) are also implemented.

LIFING solves fatigue with PSD signals, adopting the Dirlik or Narrow Band approach; PSD signal can be superposed to static conditions, defining mean stress offsets.



# VIRTUAL STRAIN GAUGE, MULTIAXIAL Assessments



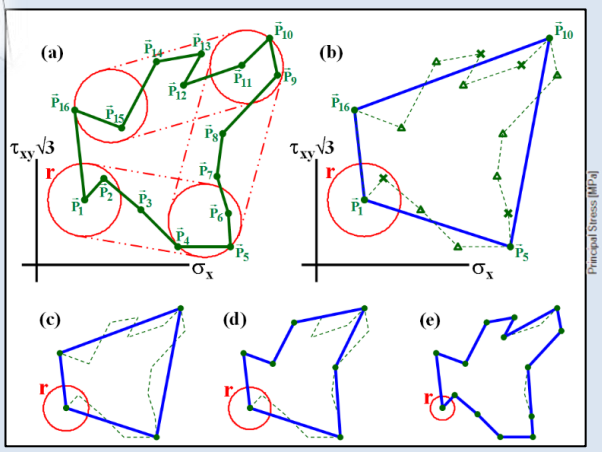

**The user can put virtual strain gauges on the FEM surfaces and extract directly stress tensor time histories, which can be processed**

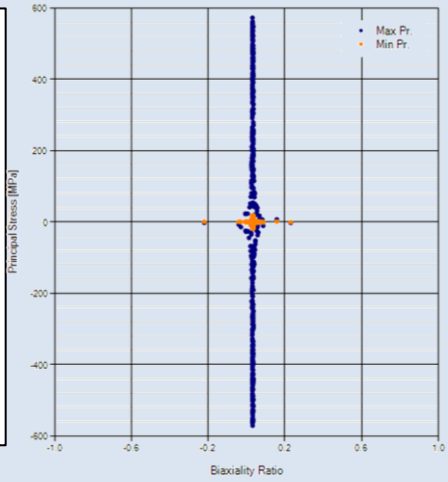
- **Filtering (uniaxial and multiaxial Racetrack Filter implemented)**
- **Counting (Rainflow, Range-Pair)**
- **Exceedence charts and Histograms are plotted**

**Multiaxiality can be assessed with**

- **Max principal and biaxiality ratio charts**



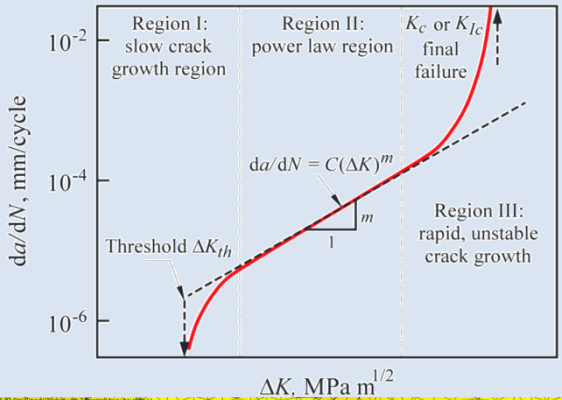



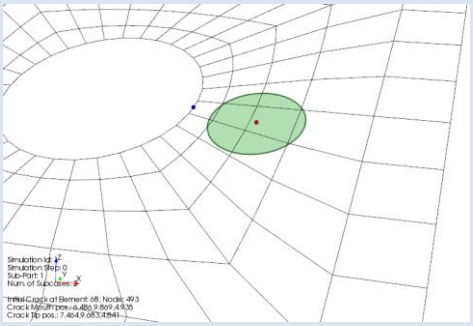

# CRACK GROWTH

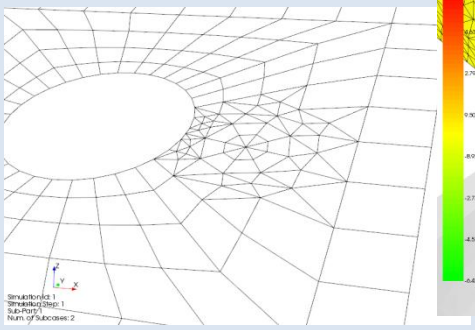
**Planar sub-models can be Crack Growth analyzed:**

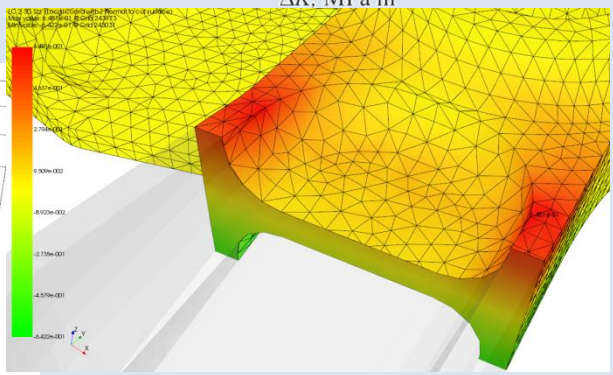
- **Crack(s) are introduced by the user (multiple cracks, i.e. wide-spread fatigue is analyzed), or are automatically introduced at fatigue hot spots.**
- **Crack(s) are automatically propagated (FEM is remeshed, calculated, based on sub-model boundary conditions, and Stress Intensity Factors are step-by-step calculated with J-Integral or displacement correlation.**

$$J := \int_\Gamma \left( W\, dx_2 - \mathbf{t} \cdot \frac{\partial \mathbf{u}}{\partial x_1}\, ds \right) = \int_\Gamma \left( W\, dx_2 - t_i \frac{\partial u_i}{\partial x_1}\, ds \right)$$



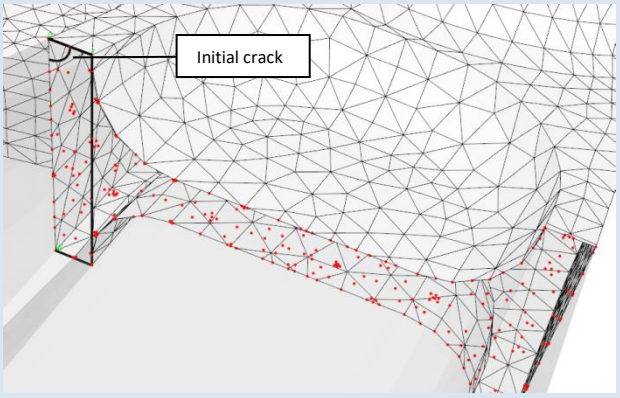




- **Cracks can be stop-drilled and mesh can be altered with local refinement and holes introduction.**

**3D Sections from solid models can be analysed:**

- **Section cuts are defined in the model, crack (surface or corner) is introduced.**
- **SIFs are calculated with Newman-Raju solution corrected with Glinka's Weight Function correction to account variable stresses in width and thickness.**




**Once the crack propagation simulation is performed, Crack Growth Life is calculated by integrating da/dN model (NASGRO database implemented).**

$$\frac{da}{dN} = C\left[\left(\frac{1-f}{1-R}\right)\Delta K\right]^n \frac{\left(1-\frac{\Delta K_{th}}{\Delta K}\right)^p}{\left(1-\frac{K_{max}}{K_c}\right)^q}$$

**Generalized Willemborg Crack Retardation Model can be used.**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