HyperLife

Overview & Feature Presentation : v2026

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Agenda

Introduction : Fatigue Portfolio

OptiStruct Fatigue vs HyperLife

HyperLife : Profiles and High-Level Feature Overview

Q&A

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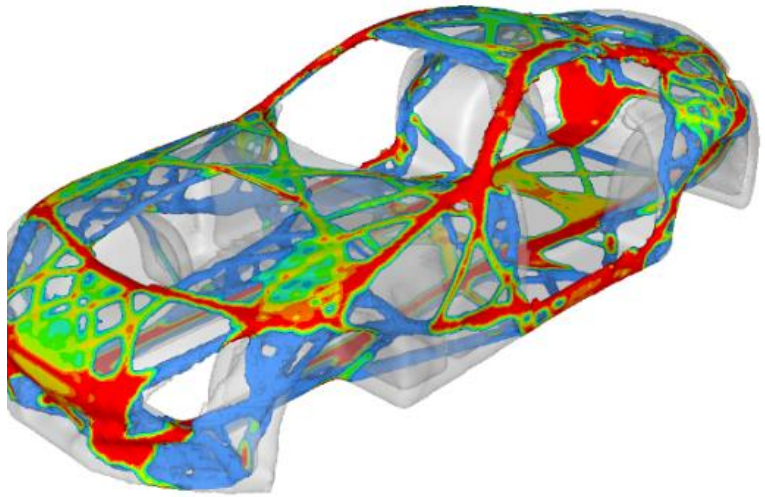
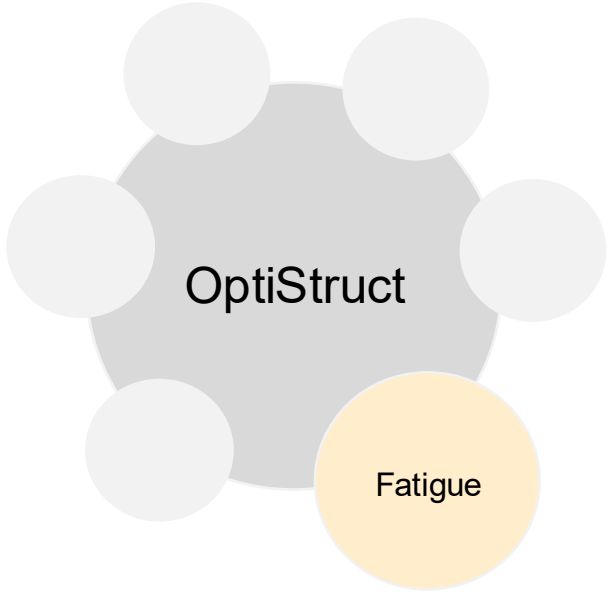
Fatigue Solutions

OptiStruct Fatigue and HyperLife





OptiStruct

Optimization-enabled Structural Analysis

Linear, nonlinear, vibrations, acoustics, shock, response spectrum, fatigue, thermal, multiphysics, optimization

Implicit + explicit

One Model One Solver

HyperLife

Standalone Fatigue Solver

Comprehensive, easy-to-learn solution for fatigue and durability analysis.

Solver neutral framework that's compatible with all major FEA results.

Independent Fatigue Solver
HyperLife

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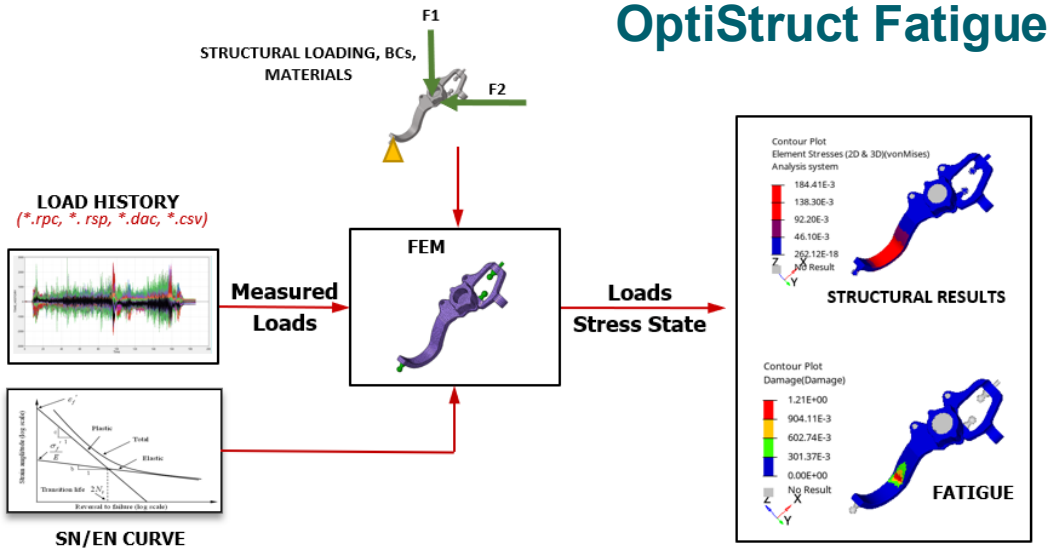
Fatigue Workflows

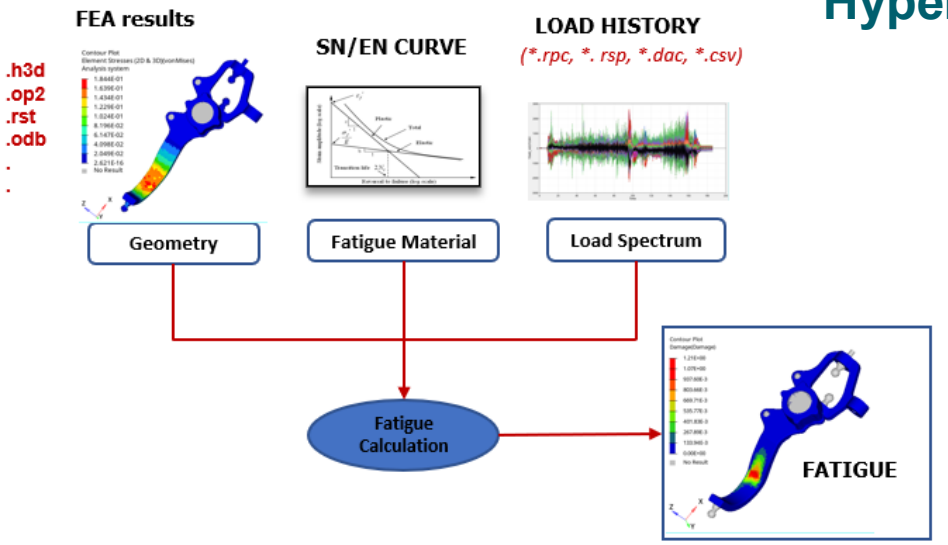
OptiStruct Fatigue vs HyperLife

OptiStruct Fatigue



- Unified Ecosystem: Structural Analysis (Static and Non-linear Static) and Fatigue evaluation is performed in single session
- Multiple type of Fatigue Analysis in a single analysis session
- Optimization enabled: Fatigue performance can be input as design response together with other structural responses

HyperLife



- Solver neutral framework: Commonly used FEA results files are input
- Guided Workflows
- Fatigue MatDB included
- Special Module for non-conventional fatigue assessment based on Norms - HyperLife Weld Certification

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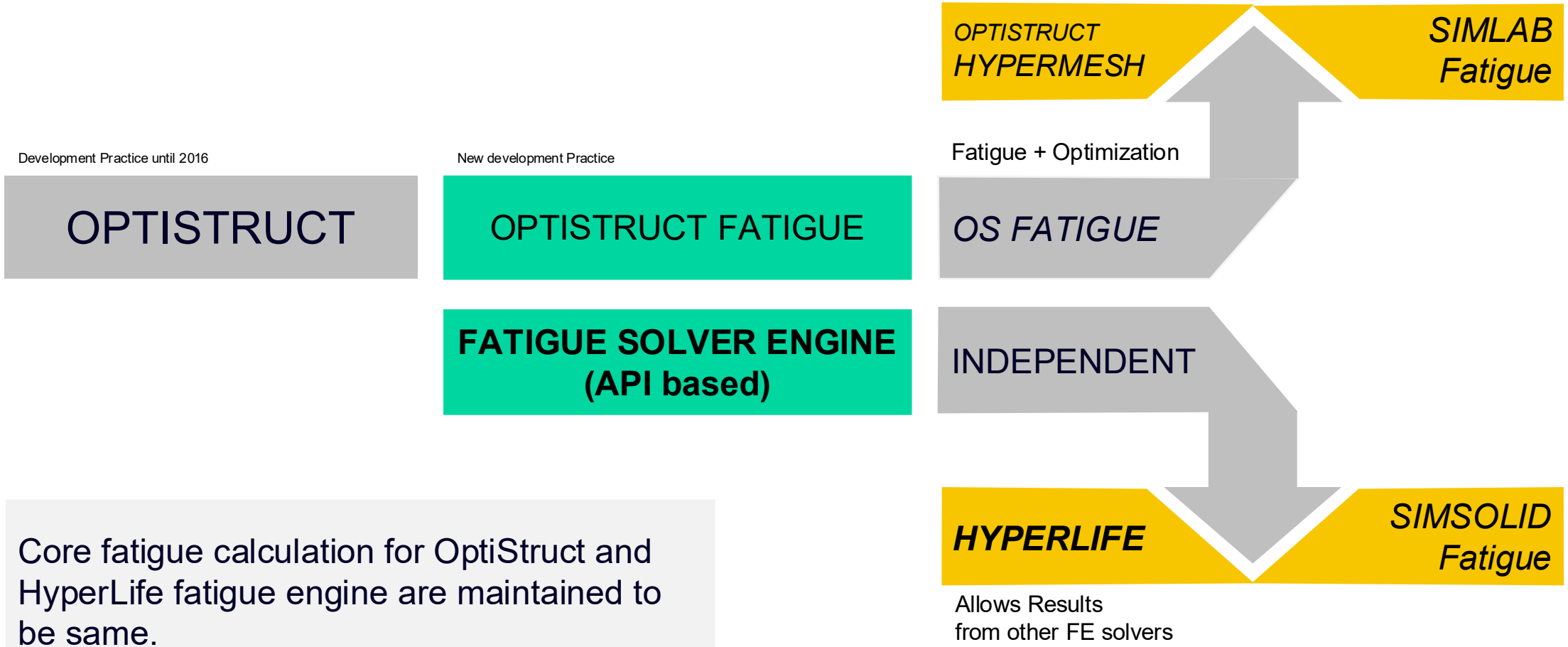
Fatigue Development

Architecture : OptiStruct Fatigue, HyperLife and Fatigue Solver Engine



Core fatigue calculation for OptiStruct and HyperLife fatigue engine are maintained to be same.

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HyperLife - Profiles

HyperLife

HyperLife Basic

01

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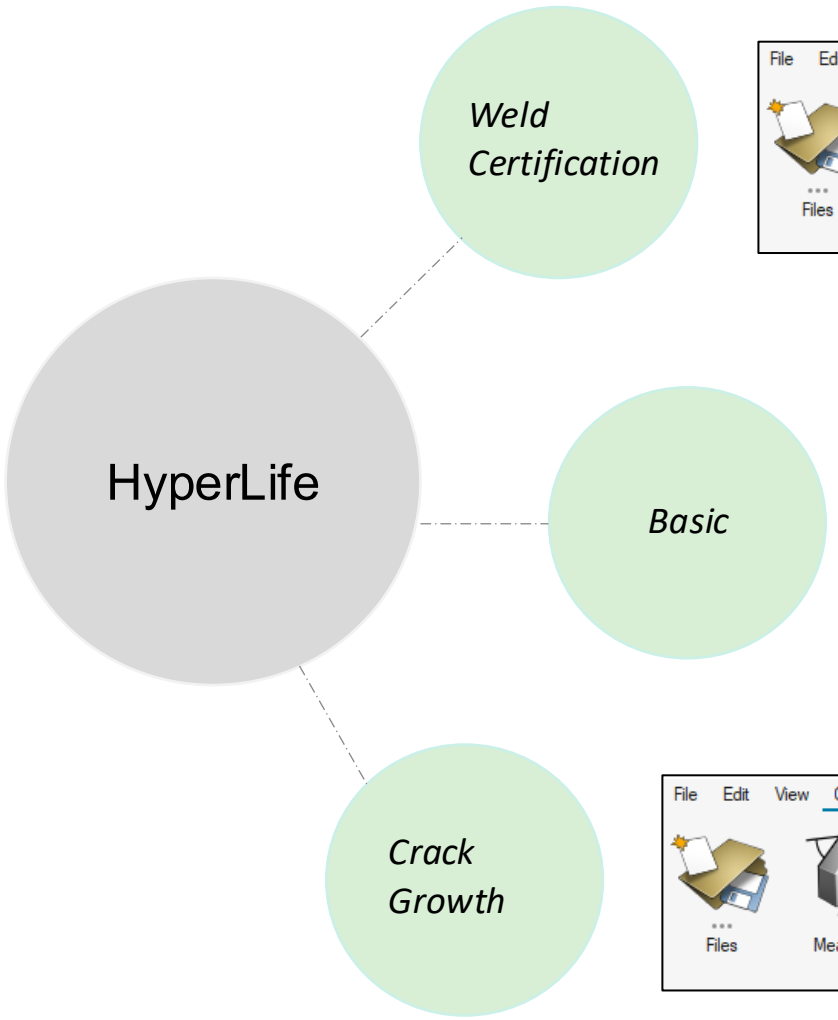
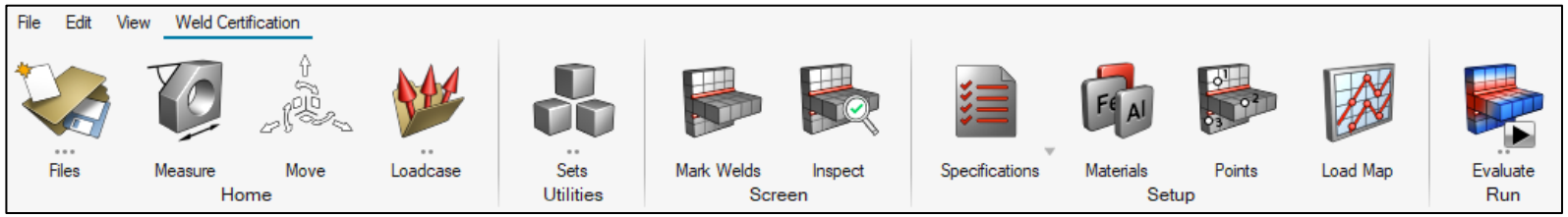
HyperLife

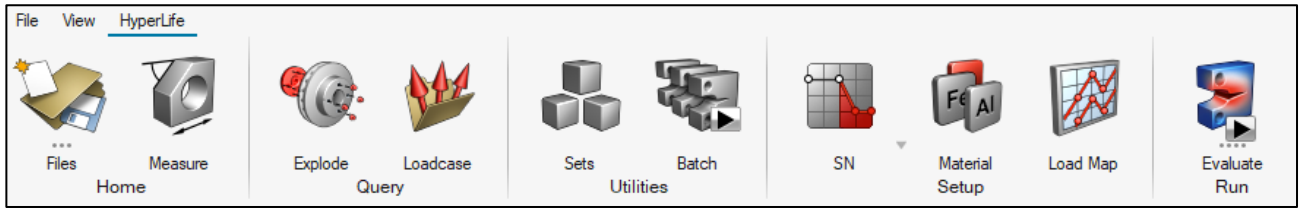
Profiles



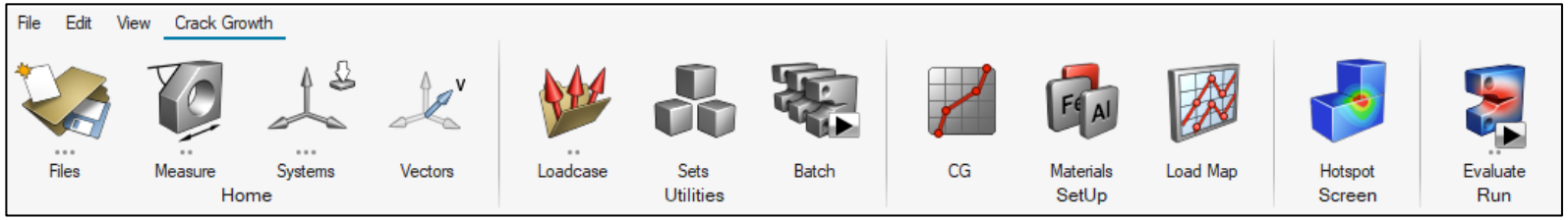
Seam Weld Fatigue : Norms (FKM, EuroCode etc)



Stress Life / Strain Life / Welds / Safety Factor



Crack Growth : Total Life Approach (v2024.1)



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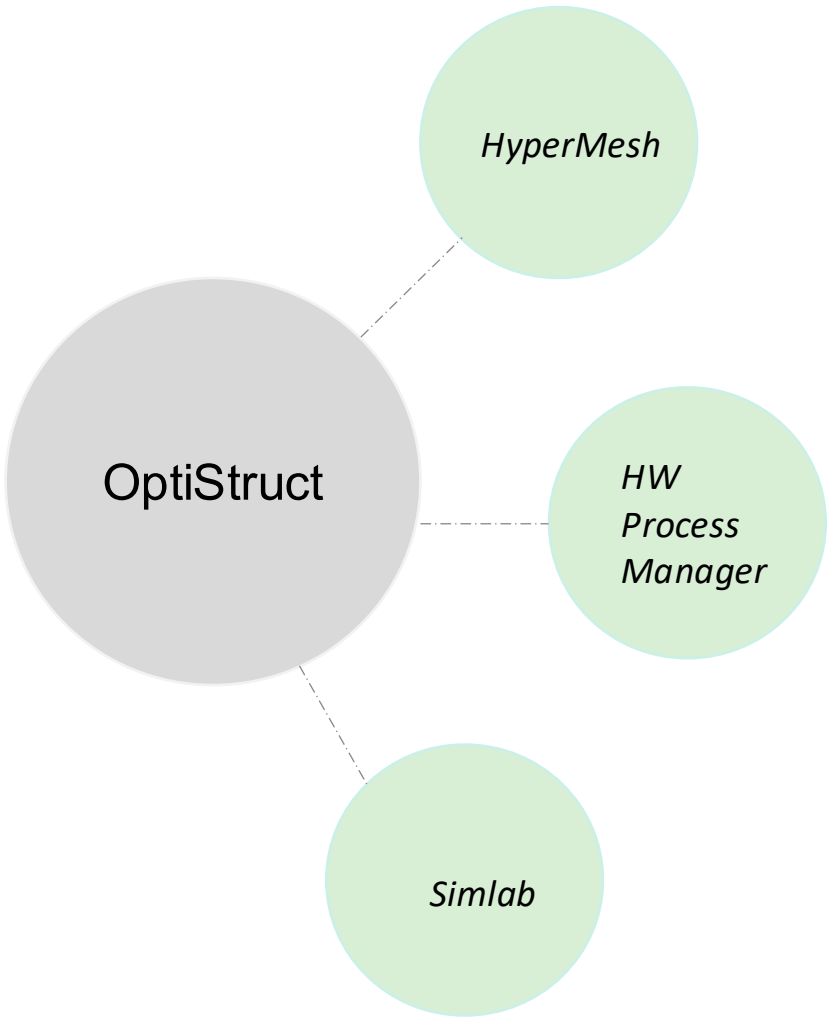
OptiStruct

Accessing Fatigue options on UX



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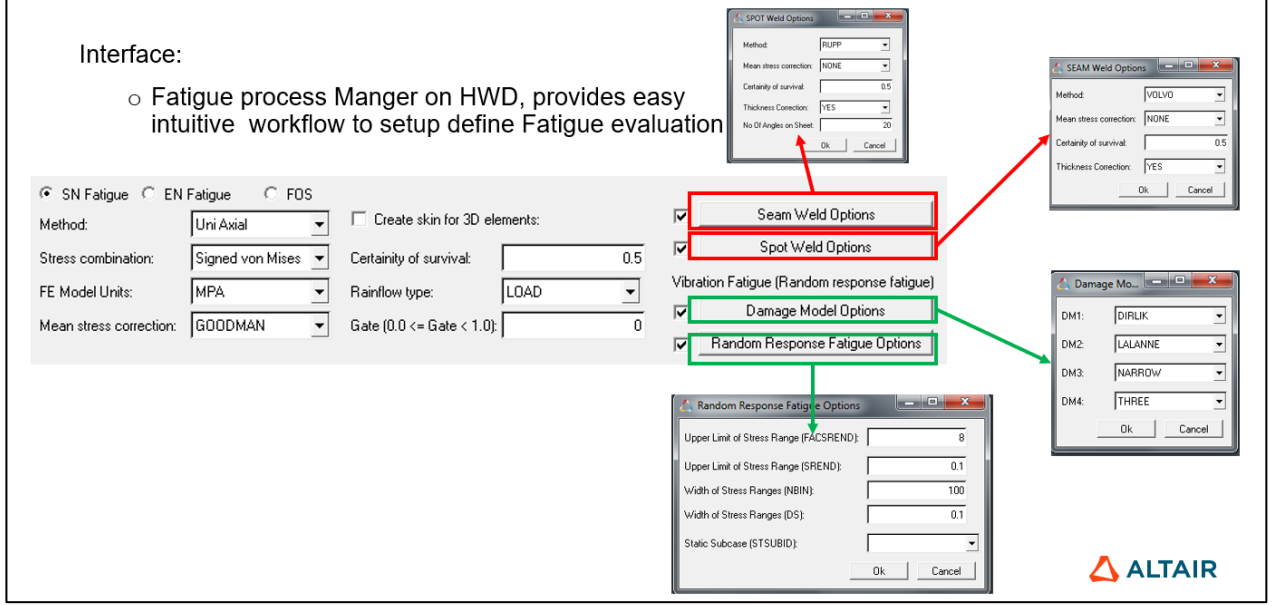
Process manager enhancement on hwd

Interface:

- Fatigue process Manger on HWD, provides easy intuitive workflow to setup define Fatigue evaluation



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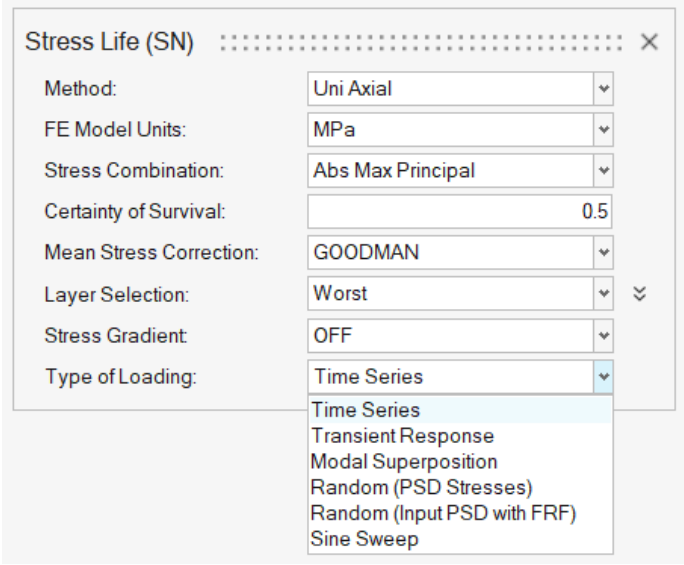
Fatigue Loading

OptiStruct and HyperLife



Loading	Static	Transient	Modal Superposition	Vibrational Loading					
Solver				Random Fatigue FRF + PSD Stress	Random Fatigue PSD Stress	Sine-Sweep	Sine-on-Random	Sine-Sweep on Random	Multiple Sine Tones
OPTISTRUCT	✓	✓	✓	na	✓	✓	✓	✓	✓
HYPERLIFE	✓	✓	✓	✓	✓	✓			

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Fatigue Methods

OptiStruct and HyperLife

Supported in OptiStruct

Supported in HyperLife

Approach	Method	Inputs	Mean Stress Models/ Damage Models	Plasticity
Stress Life (Damage/ Safety Factor/ Static Failure)	Uniaxial	Combined stress	Goodman, Gerber, Gerber2, Soderberg, FKM	-
	Multiaxial	Stress tensor	Goodman, FKM, Findley	-
Strain Life (Damage assessment)	Uniaxial Multiaxiality check 2-pass run	Combined stress/strain Stress + Strain	Smith-Watson Topper, Morrow, Morrow2 Bergmann	Neuber, Hoffman-Seeger
	Multiaxial	Stress/Strain tensor	Smith-Watson Topper, Fatemi-Socie Model, Brown-Miller Model	Jiang's plasticity model Hoffman-Seeger Biaxial model
Dang Van Criteria (FOS)	Multiaxial	Stress tensor	-	-

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Weld Fatigue

OptiStruct and HyperLife

Supported in OptiStruct

Supported in HyperLife

Solver	Weld Method	Approach
OPTISTRUCT (Seam)	VOLVO	Shell element modeling Fillet Welds modeled Hotspot Stress Damage in TOE and ROOT Optimization Enabled
HYPERLIFE (Seam)	VOLVO	Shell element modeling Fillet Welds modeled Hotspot Stress Damage in TOE and ROOT
	Equivalent Structural Stress Approach (EQSS) – Beta/WIP	Solid element modeling Fillet Welds modeled Equivalent Structural Stress
	HyperLife Weld Certification Regulation Based Seam Weld Fatigue	1D representation of Stress Nominal or Hotspot Stress Regulation based Fatigue • FKM, EuroCode 3, DVS 1608 , DVS 1612 • SN based approach • ERRI RP 60, IEC Base metal Fatigue
OS/ HyperLife (Spot)	RUPP	1D / ACM nugget realization on shell Sheet and Nugget Failure Optimization enabled

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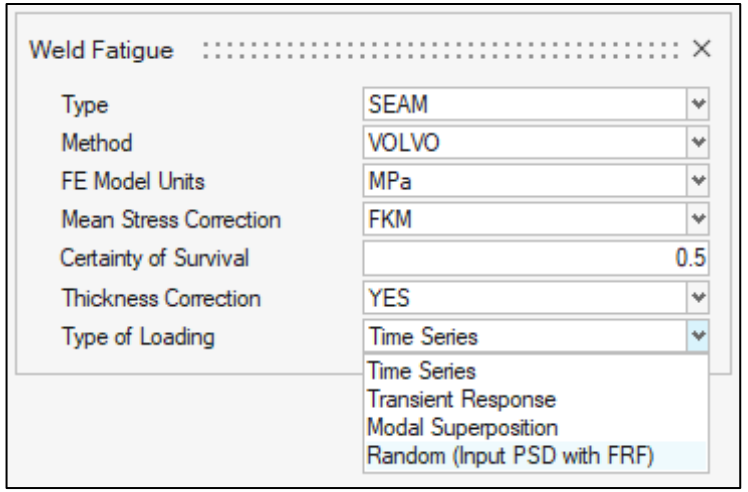
Weld Fatigue Loading

OptiStruct and HyperLife



Weld Fatigue	SOLVER	METHOD	FATIGUE LOADING TYPES				
			Time Series (Pseudo Static)	Transient	Modal Superposition	PSD Dirlik, Lalanne, Narrow band, THREE	Sine Sweep
Spot Weld	OptiStruct	RUPP	✓	✓	-	✓	-
	HyperLife	RUPP	✓	✓	-	✓	-
Seam Weld	OptiStruct	VOLVO	✓	-	-	✓	-
	HyperLife	VOLVO	✓	✓	✓	✓	-

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Fatigue Loading

HyperLife

Approach	Method	Fatigue Loading Types					
		Static load	Transient load	Modal Superposition	Vibrational load		
					Random Fatigue FRF + PSD Stress	Random Fatigue PSD Stress	Sine-Sweep
Stress Life	Uniaxial	Yes	Yes	Yes	Yes	Yes	Yes
	Multiaxial	Yes	Yes	Yes	No	No	No
Strain Life	Uniaxial	Yes	Yes	Yes	Yes	Yes	Yes
	Multiaxial	Yes	Yes	Yes	No	No	No
Infinite Life	Dang Van (FOS)	Yes	Yes	No	No	No	No
Weld Fatigue	Spot	Yes	Yes	No	Yes	No	No
	Seam	Yes	Yes	Yes	Yes	No	No

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Embeded Material Database

HyperLife

File View HyperLife

Files Measure Home | Explode Loadcase Query | Sets Utilities | SN | Material Setup | Load Map | Evaluate Run

Components

Database from MATDAT.com

- SN and EN data available
- Included in standard installation

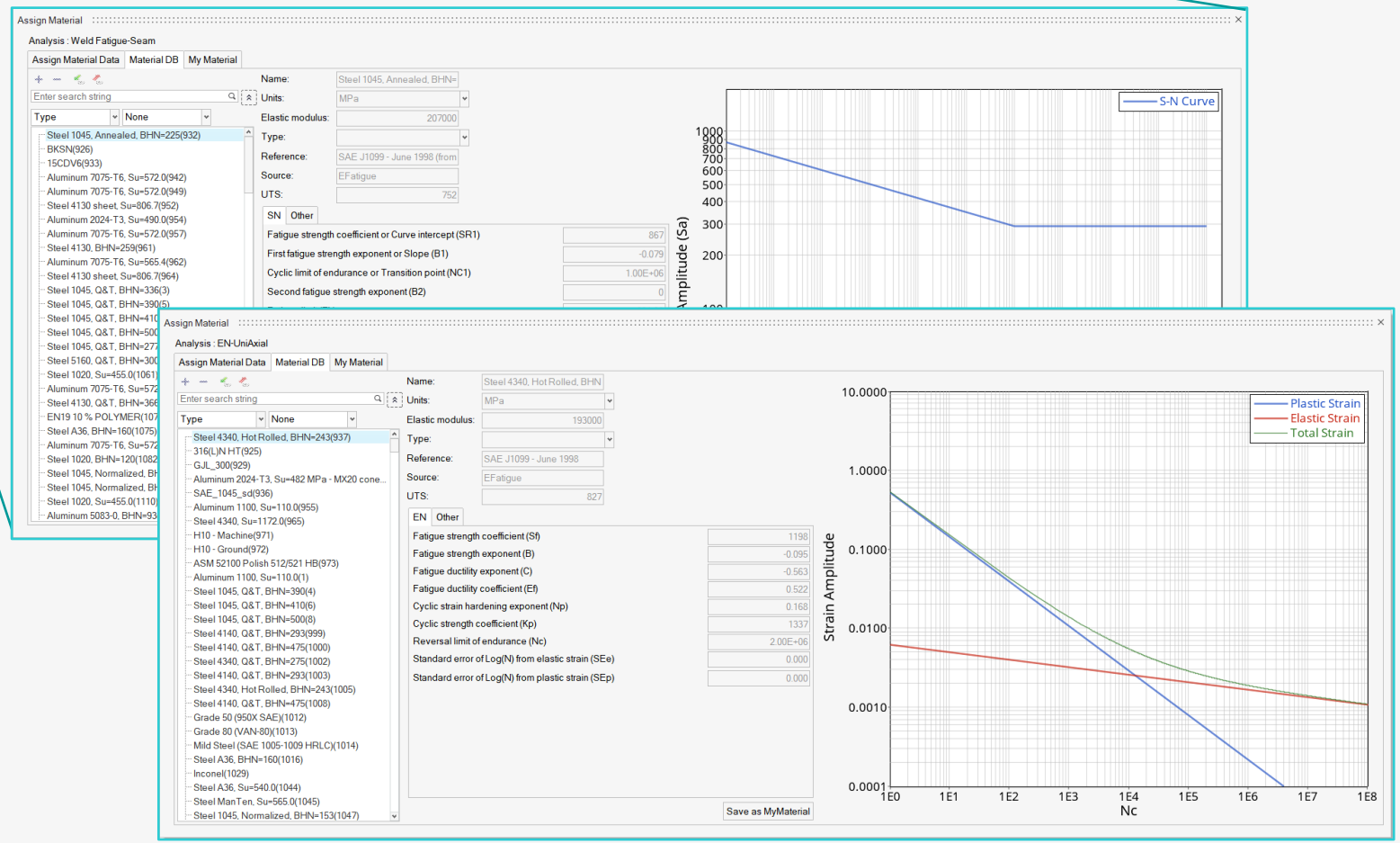
Default Material for Seam and Spot

User DB placeholder

- Create New/Edit
- Estimation of Material curve from UTS.
- CSV/XML Import/Export

AMDC (Altair Material Database Center)

- Download Material in OS and HL formats



Y Z X

0.000s / 0.000s

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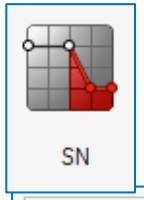
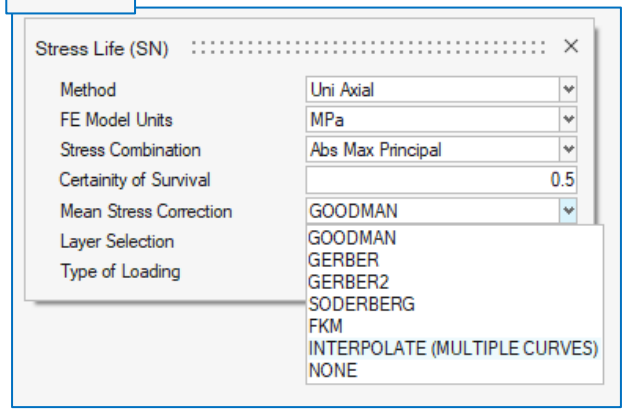
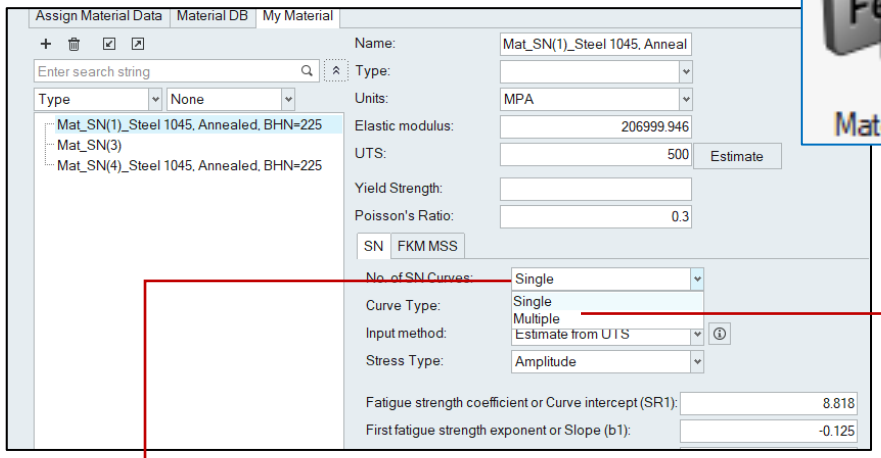
Embeded Material Database

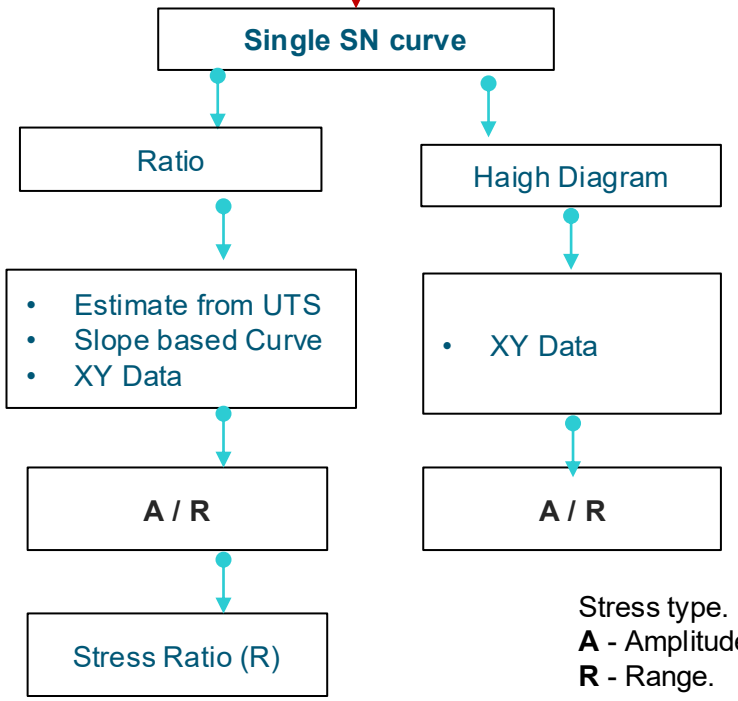
HyperLife

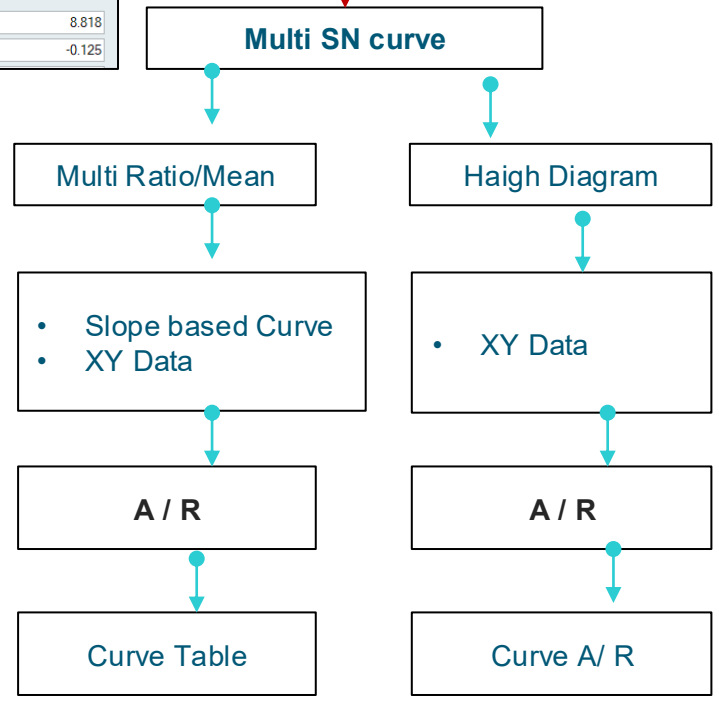
- Multi SN curve Support (Multi Ratio/Mean/Haigh)
- Stress Ratio for Single SN curves
- SN curve in XY Data format (Single/Multiple)











Stress type.
A - Amplitude.
R - Range.

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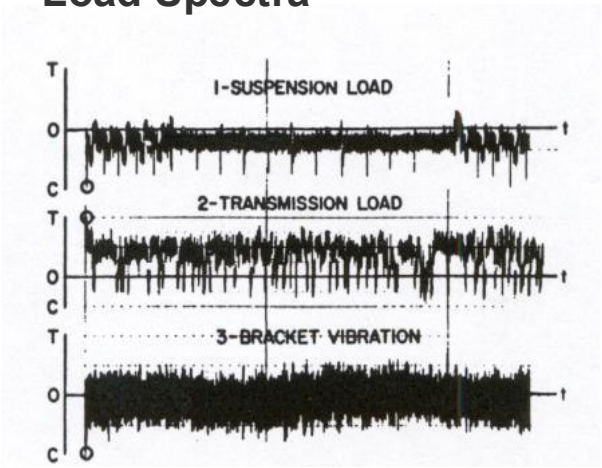
Event Assignement

HyperLife

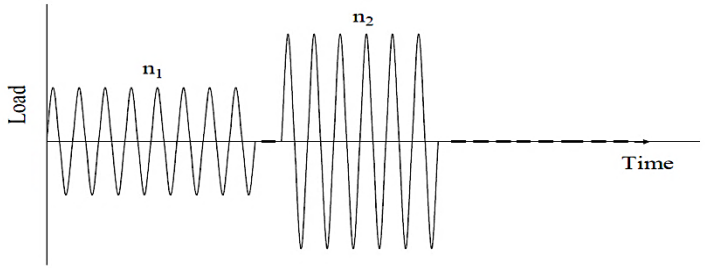
Supported Load Histories

- Constant Amplitude :
  Simple Completely reversed cycle
- Block Loading
  Blocks of constant amplitude loading
- Time Data
  i. Variable amplitude loading
  ii. supported formats : csv, rpc, rsp, dac,

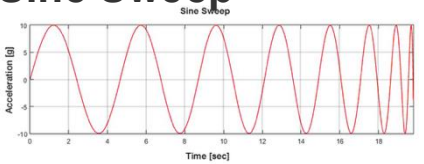
Load Spectra



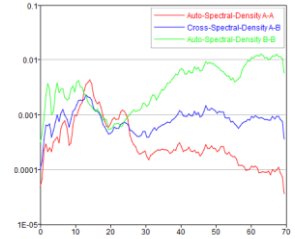
Block Loads



Sine Sweep



PSD



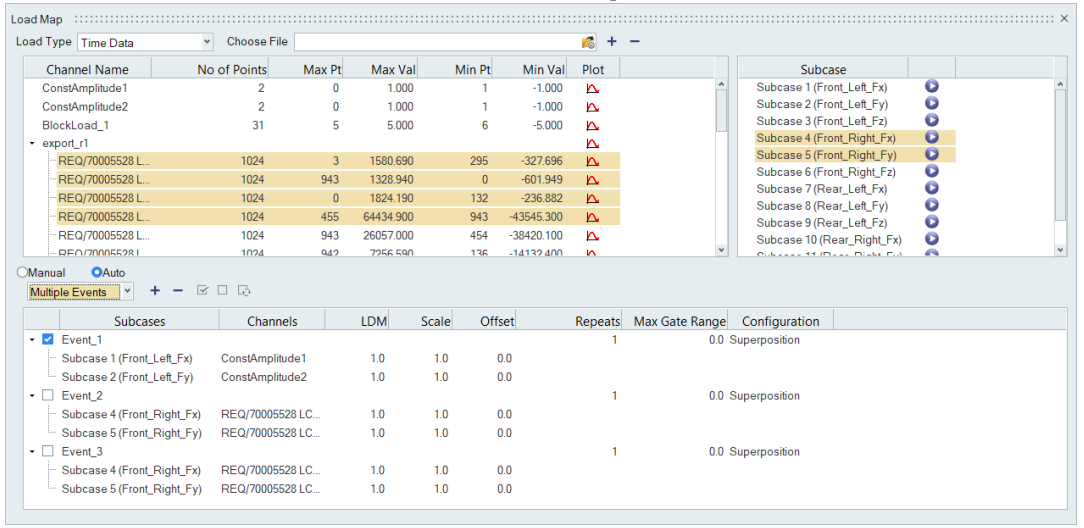
Event Creation

- Auto Pairing of Subcases and Load Spectra
- Manual creation
  (Drag drop the required subcase-load history combination)

Duty Cycle options (XML, CSV)

ASSIGN Cards for Loading History Channels in OptiStruct

Load Map



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HyperLife

Run Setup file XML

Input files contain the following major sections:

- Preferences
  - Rainflow output, etc
- Input Files
- Model Configuration
  - SN/ eN/ Weld/ Dangvan
- Material Assignment and Material setup
  - Parts/set assignment to mat
- Loadmap with Duty Cycle options
  - Event List
  - Duty Cycle XML
- Evaluate
  - Advance output
  - Advance evaluation options

```
<?xml version="1.0" encoding="UTF-8"?>
<HyperLifeInput profile="Basic" version="2022.1.0.31">
  <Preferences>
    <RainflowDataOutput>True</RainflowDataOutput>
    <EventWiseResult>False</EventWiseResult>
    <RunAtModelLocation>True</RunAtModelLocation>
  </Preferences>
  <InputFiles>
    <ModelFile>Cradle.fem</ModelFile>
    <ResultFile>Cradle.h3d</ResultFile>
    <ResultFile>Cradle2.h3d</ResultFile>
  </InputFiles>
  <UserSet>
    <UserSetFile entity_type="element">Set_critical_elements.csv</UserSetFile>
  </UserSet>
  <ModelConfig type="SN" unit="MPA">
    <method>Uni Axial</method>
    <stresscombination>Abs Max Principal</stresscombination>
    <survivalfactor>0.5</survivalfactor>
    <correction>GOODMAN</correction>
    <layer>Worst</layer>
    <typeofloading>Time Series</typeofloading>
  </ModelConfig>
  <MaterialSetup type="SN">
    <UserMaterialFile></UserMaterialFile>
    <EntityList evaltype="Sets">
      <entity id="" matname="Aluminum 7075-T6, Su=572.0(949)" name="Set_critical_elements" poc
        <SurfaceFinish Option="NONE">0.1</SurfaceFinish>
        <SurfaceTreatment Option="NONE">0.1</SurfaceTreatment>
        <TemperatureFactor Option="NONE"></TemperatureFactor>
        <FKMMMS Option="4 Slopes">
          <SlopeinRegime2>0.15</SlopeinRegime2>
          <SlopeinRegime1>0.00</SlopeinRegime1>
          <SlopeinRegime3>0.05</SlopeinRegime3>
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        </FKMMMS>
      </entity>
    </EntityList>
    <ExcludeSets></ExcludeSets>
  </MaterialSetup>
  <LoadMap>
    <LoadMapFile type="xml">fatigue_loading.xml </LoadMapFile>
  </LoadMap>
  <Evaluate>
    <runname>Cradle_fatigue_setup</runname>
    <AnalysisLocation>ELEMENT</AnalysisLocation>
    <numprocessor>10</numprocessor>
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```


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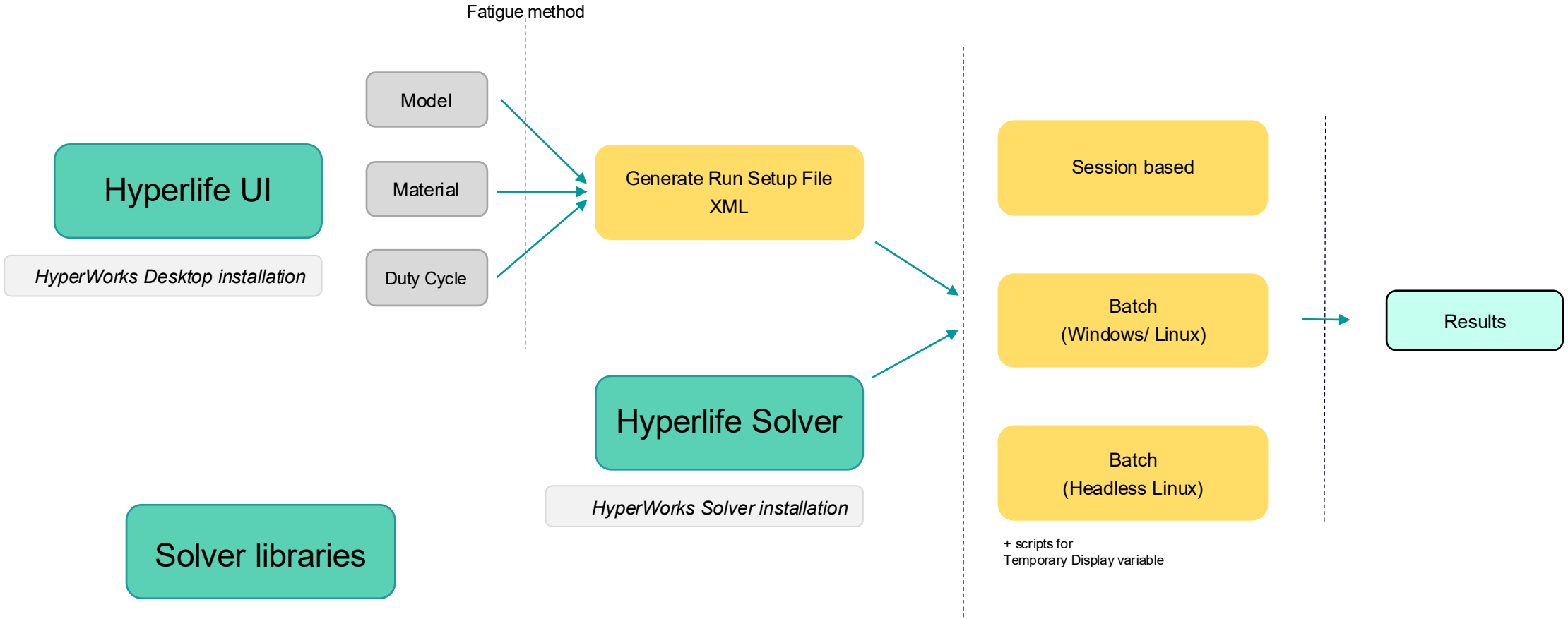
HyperLife

Batch evaluation



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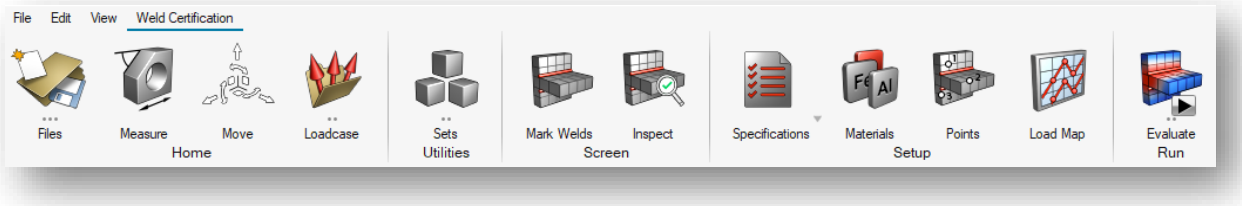
HyperLife - Profiles

HyperLife Weld Certification



HyperLife Weld Certification

02

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HyperLife Weld Certification

Introduction

Fatigue Analysis Type

- Stress Life (SN)
- Strain Life (eN)
- Weld Fatigue
- Vibration Fatigue

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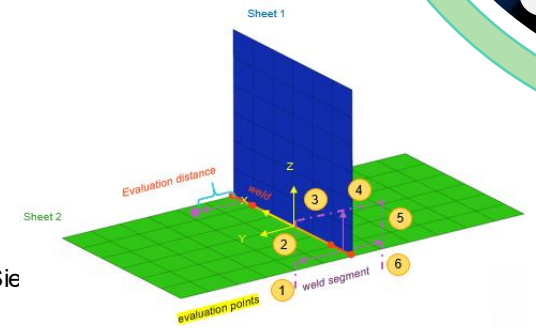
Norm based Fatigue

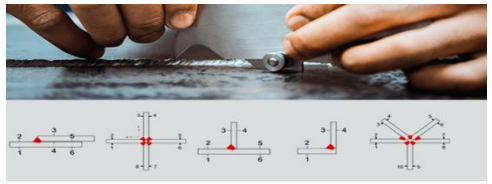
- **Eurocode 3**
- **DVS 1612**
- **DVS1608**
- **FKM**
- **ERRI B12 RP60**
- **IEC 61373**
- **SN**
  - **Range envelope**
  - **Variable Amplitude**
  - **Damage / utilization**

Future scope

- **Auto Weld Detection in HyperWorks**
- **EN17149 via SN Damage Iterative**

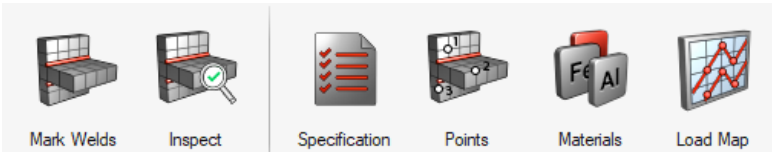


Auto Weld Detection
- ***Seam Weld Browser***



Regulation based Fatigue Assessment for Welds

Standard Approach with ***guided workflow***



Extension to ***Base Metal*** evaluation

Static Assessment

Heavy Industry, Rail, Marine, etc

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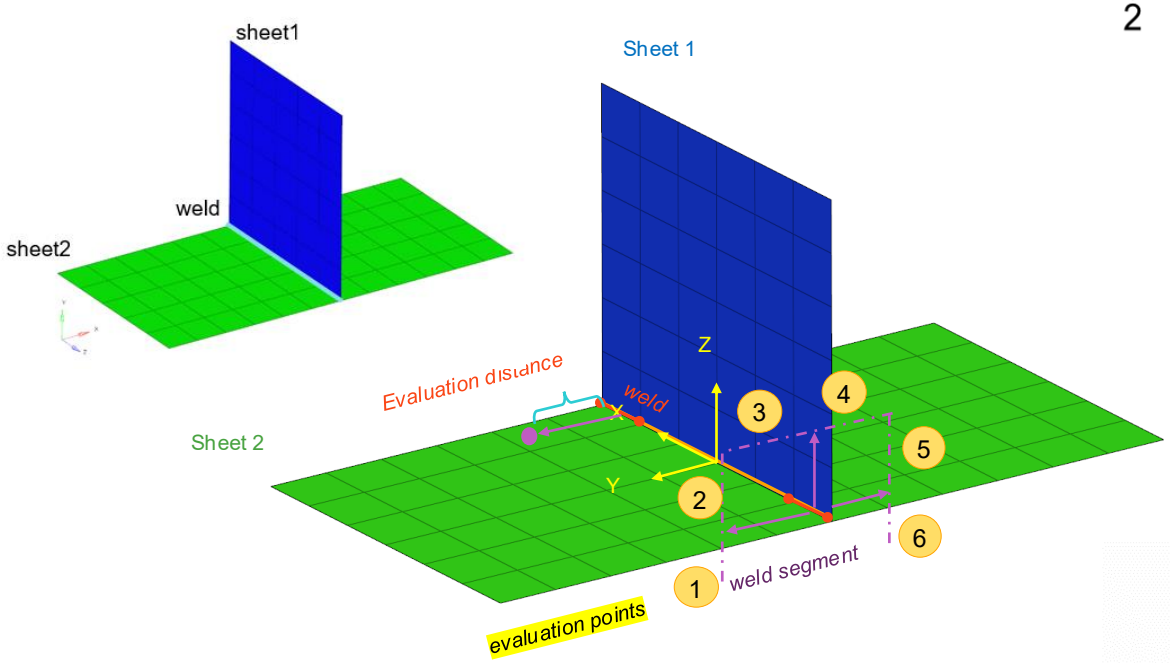
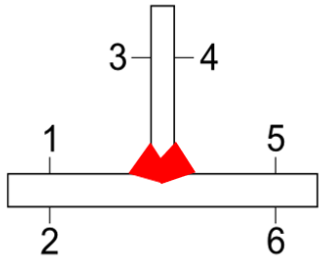
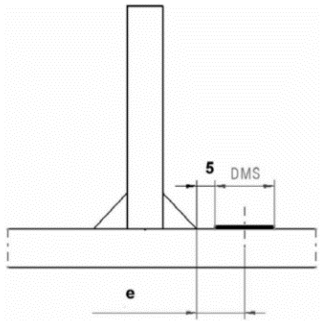
HyperLife Weld Certification

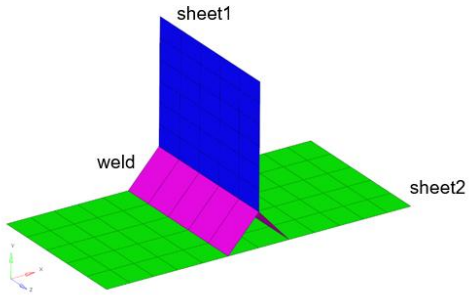
Approach

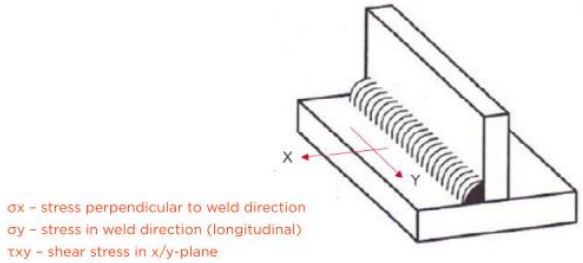


1-6 evaluation points for each T-connection

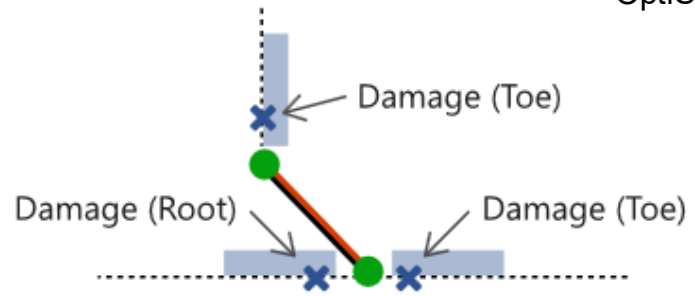








OptiStruct



3 evaluation points for each fillet weld

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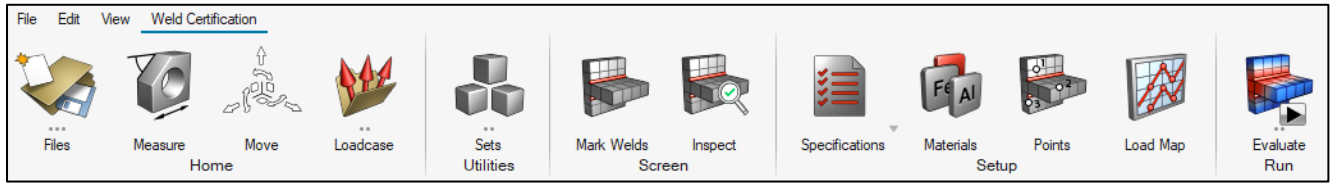
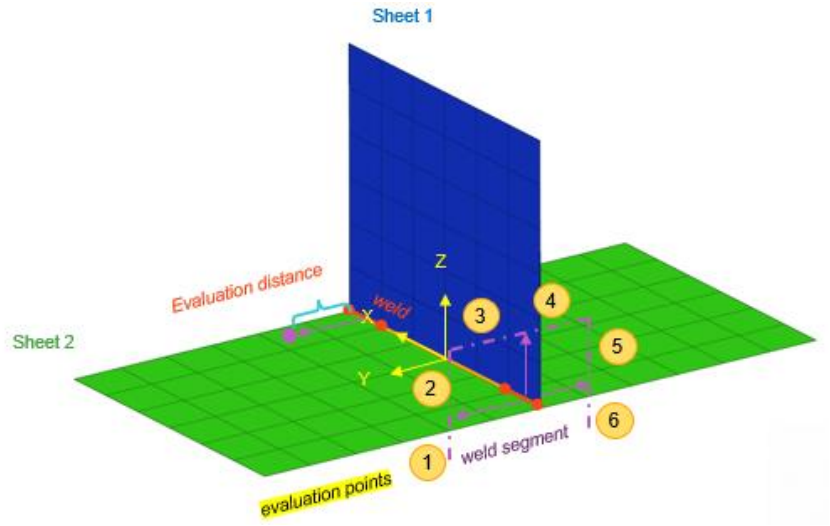
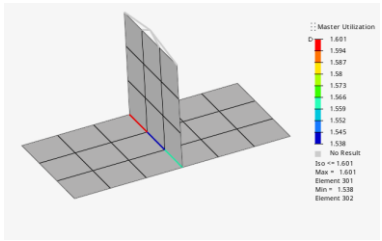
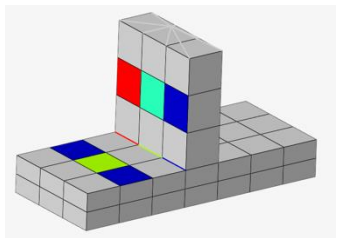
HyperLife Weld Certification

Workflow









Weld Detection : 2D-2D, 3D-3D
Weld type : L, T, B, O, X, M


Specifications

Weld Detection → Regulation / SN

Weld Orientation


Mark Welds

Regulation : EC3, FKM, DVS …
Stress Life Module
Stress Allowables per location

1 2 n

Weld Distance

Fatigue Strength


Points

Weld Distance : Nominal / Hotspot
Stress Calculation

Utilization / Damage

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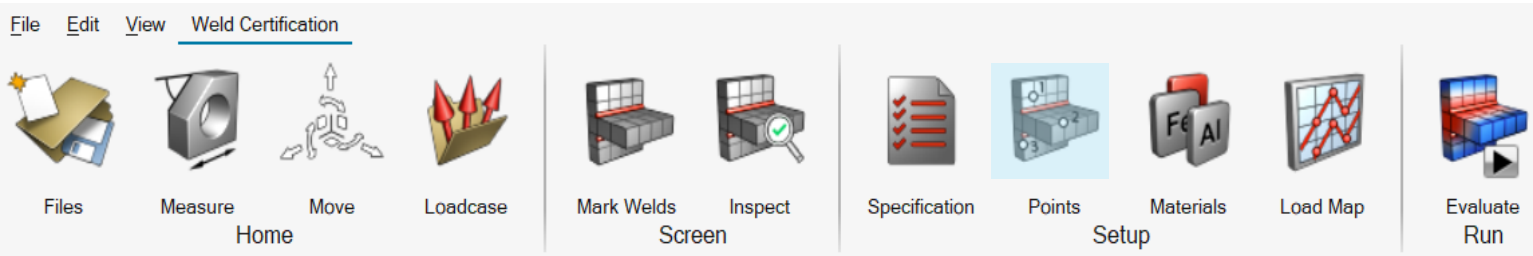


General Architecture

Weld Properties

Weld Browser

- Detection
- Organization

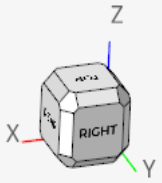
Preprocessing

Regulations

- Weld Category
  - SN Details,
  - Allowables
- Fatigue Strength Correction Factors

Approach
(Stress Query)

- Nominal
- Hotspot



Weld browser

Evaluation distance

General properties

Location tables

Evaluation Points

Search weldlines...

Weldline	ID	Active	Type	WeldPart	Evaluate
hlw_T2#Frame_left1#Frame_left7	1	T		10000	
hlw_T2#IC21#Outer_Frame_left	2	T		10001	
hlw_T2#Frame_left1#Frame_left8	3	T		10002	
hlw_T2#Inner_Frame_right3#Skin	4	T		10003	
hlw_T2#Clip5#Outer_Frame_right	5	T		10004	
hlw_T2#IC6#Inner_Frame_right	6	T		10005	
hlw_T2#Clip1#Skin	7	T		10006	
hlw_T2#Inner_Frame_right#Inner_Frame_right3	8	T		10008	
hlw_T2#IC62#Skin	9	T		10009	
hlw_T2#IC3#Outer_Frame_left	10	T		10010	
hlw_T2#Beam_upper7#Skin	11	T		10011	
hlw_T2#Beam_lower3#Skin	12	T		10013	

Evaluation Approach: (•) Nominal ( ) Hotspot

Evaluation Distance Calculation Method: (•) Auto ( ) Manual

Weld Category: UserDefined

Evaluation Distance

	Component	Weld Factor	Weld Width	Constant 1	1st Evaluation Distance	1st Total Distance
1	Transverse	1.0	6.0	0.5	3.0	12.0
2	Longitudinal	1.0	6.0	0.5	3.0	12.0
3	Shear	1.0	6.0	0.5	3.0	12.0

General

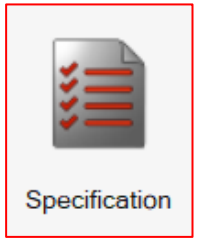
Mean Stress Sensitivity - Normal	Mean Stress Sensitivity - Shear	Grinding Bonus	Effective Weld Thickness
0.15	0.09	Yes	No

Location

	Location Point	Notch Class - Transverse	Notch Class - Longitudinal	Notch Class - Shear	Material Yield	Thickness Influence (TI)	Thickness Flag (TF)	Intern
1	Location1	F2	F2	H	270.0	1.0	t	
2	Location2	F2	F2	H	270.0	1.0	t	
3	Location3	F2	F2	H	270.0	0.7	tmin	
4	Location4	F2	F2	H	270.0	0.7	tmin	
5	Location5	F2	F2	H	270.0	1.0	t	
6	Location6	F2	F2	H	270.0	1.0	t	

Supported Specifications

Welded Evaluation



	Fatigue		Static	
Regulation	**Shell - Shell**	**Solid-Solid**	**Shell - Shell**	**Solid-Solid**
DVS1612	Yes	Yes (Abaqus/Ansys)	Yes	Yes
DVS1608	Yes	Yes (Abaqus/Ansys)	Yes	Yes
FKM	Yes	Yes (Abaqus/Ansys)	Yes	Yes
EuroCode 3	Yes	Yes (Abaqus/Ansys)	Yes	Yes
ERRI B12 RP60	Yes	Yes	No	No
IEC	Yes	No	No	No
Stress Life (SN)	Yes	Yes	No	No

Available

New support

Not supported

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HyperLife - Profiles

HyperLife Crack Growth

HyperLife Crack Growth

03

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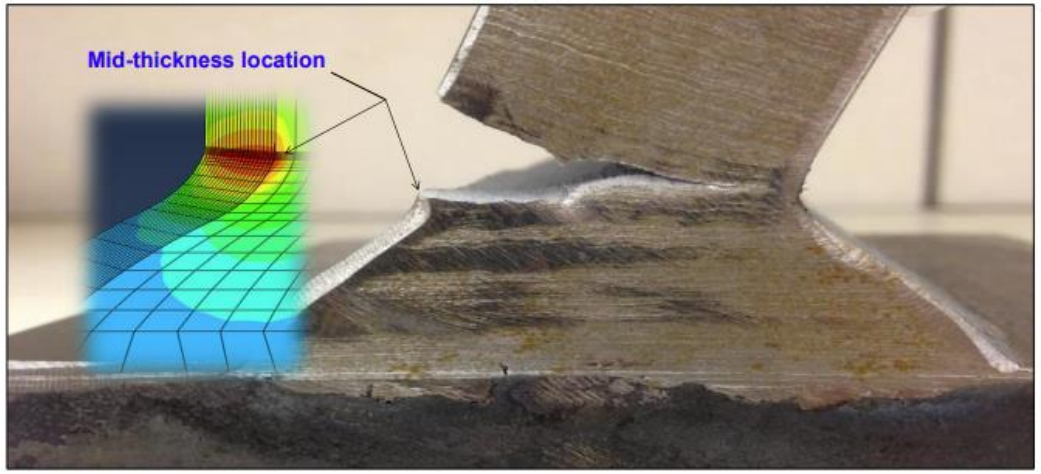
Total Life Approach

Overview

The crack growth solver in HyperLife is based on a method developed by Dr. Glinka

The solver can solve a crack growth problem considering

- **Weight function**-based stress intensity factor that uses **local stress** at the cracks.
- Variable amplitude load.
- External residual stress.
- Crack retardation.
- Short crack as well as long crack.
- Load shedding/redistribution due to growing crack.



Source : Fatigue Crack Growth Analysis, G. Glinka

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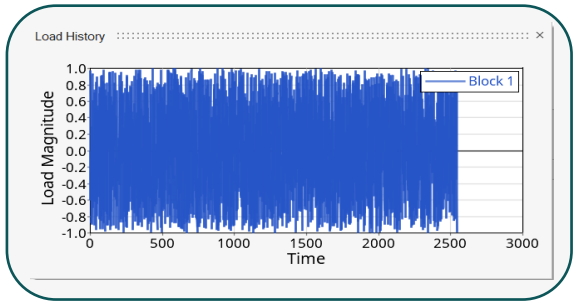
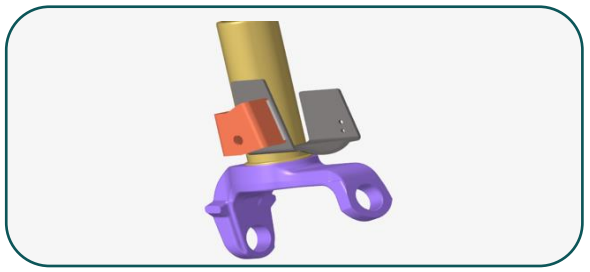
HyperLife Crack Growth

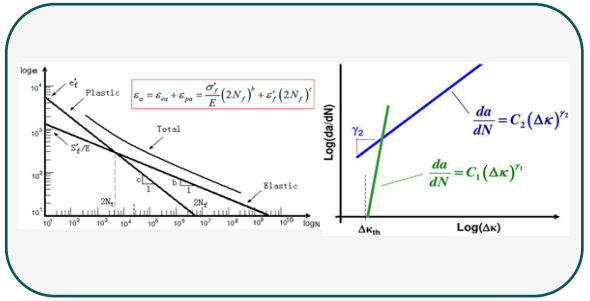
Introduction



$$\frac{da}{dN} = f(\Delta K, K_{max})$$

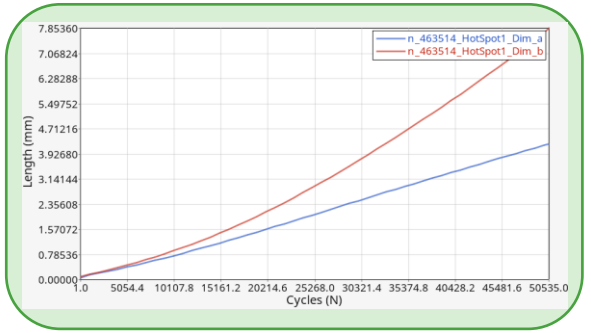
Driving force



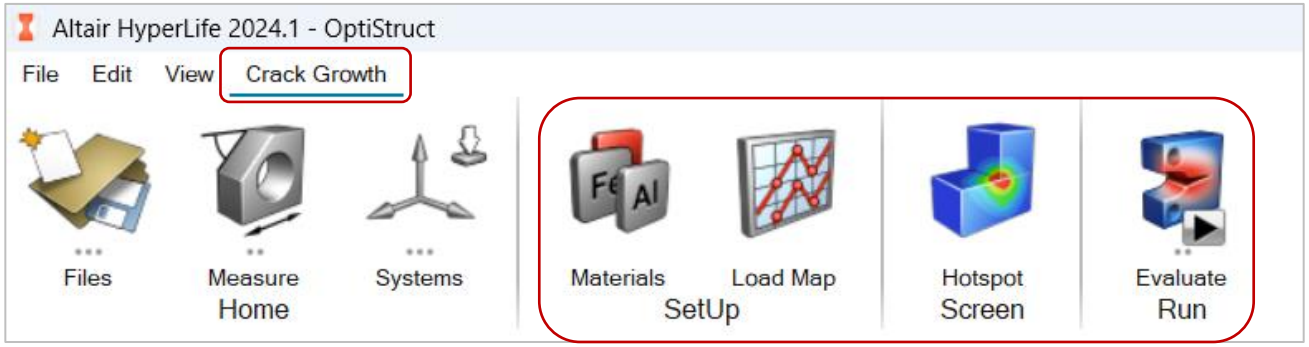


FCG model

Results



$$N = \int_{a_i}^{a_f} \frac{da}{f(\Delta K, K_{max})}$$



Linear Elastic Fracture Mechanics (LEFM)

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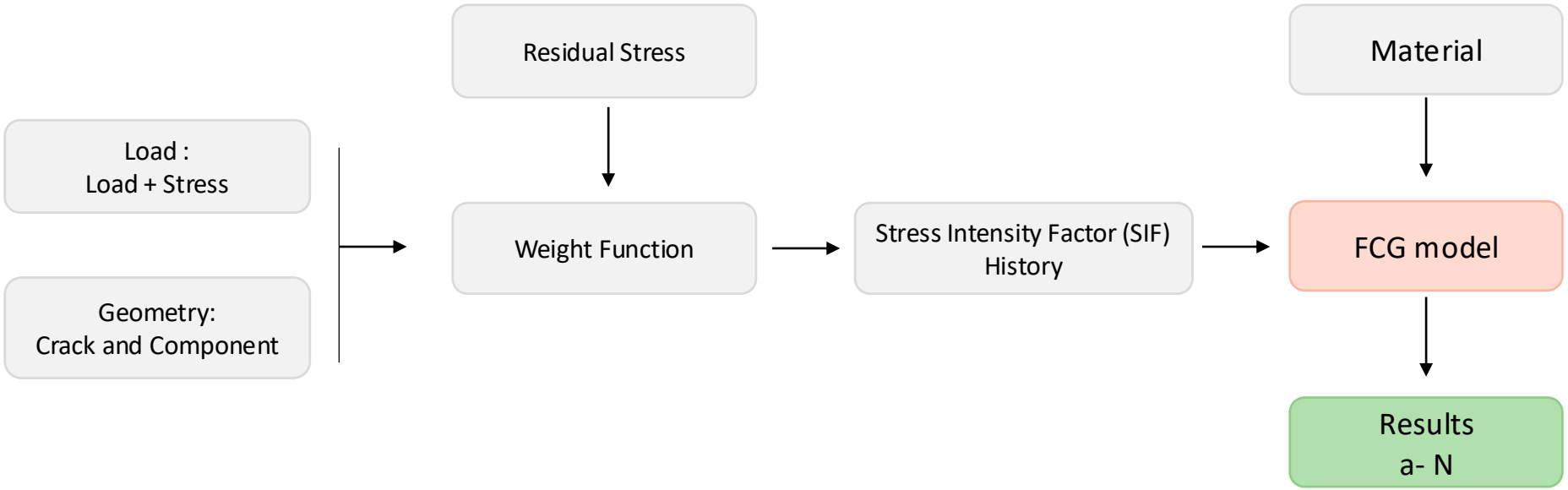
HyperLife Crack Growth

Workflow– Total Life Approach (v2024.1)

Fluctuating loads and varying crack geometry are combined to determine the K (SIF) history by using appropriate Weight Functions



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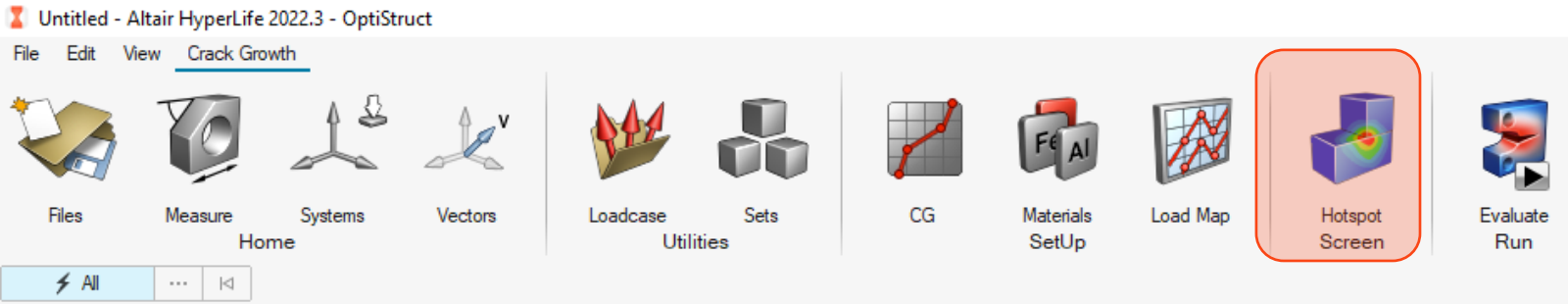
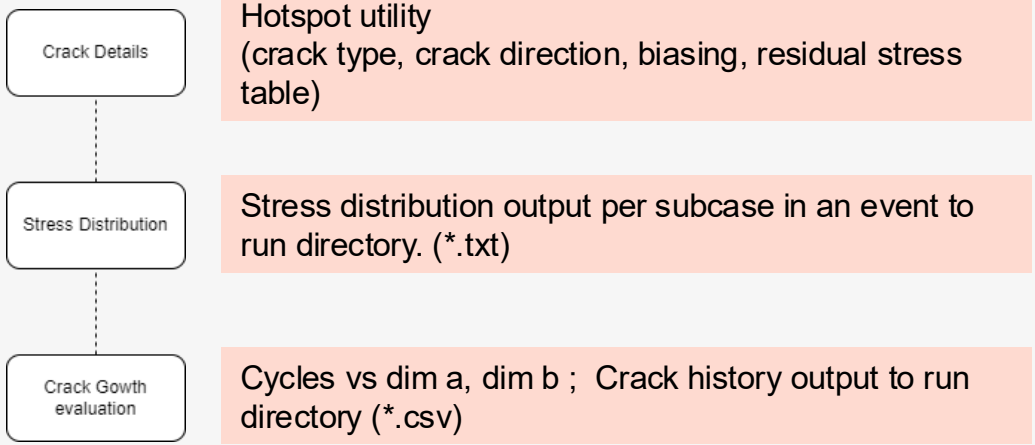


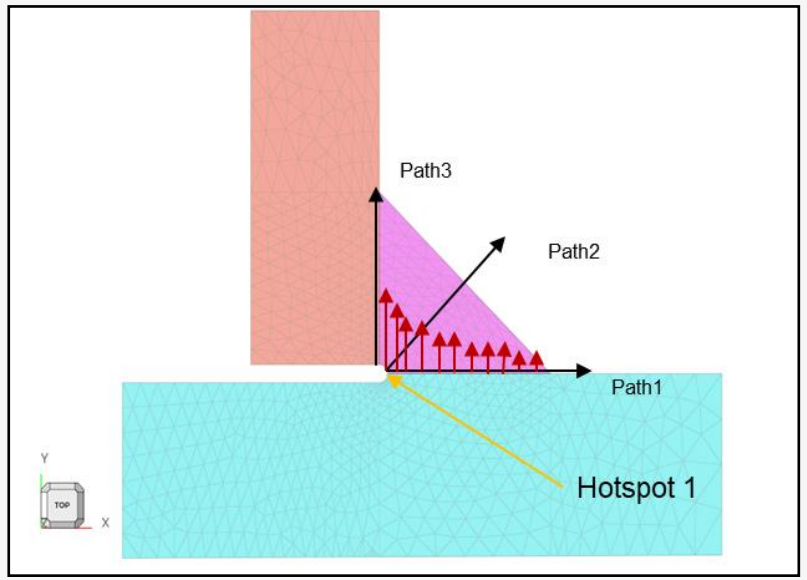
HyperLife Crack Growth

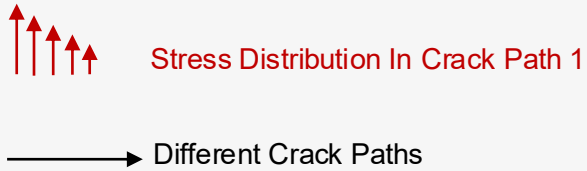
User Interface – Hotspot Definition

A hotspot is defined with:

- A Node to identify the location
- A Coordinate system to identify the crack path and Stress distribution
- The crack geometry







HyperLife Crack Growth

Workflow: Automatically Detect Hotspot Locations with Strain Life (eN)

eN uniaxial

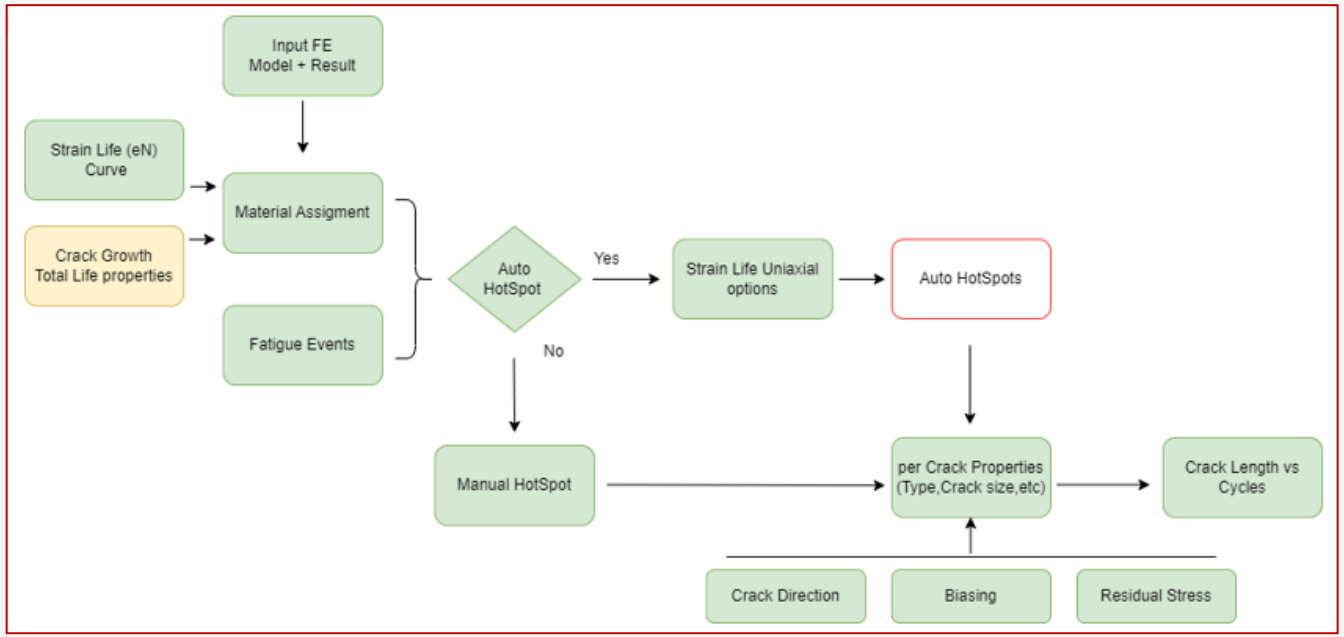
Fatigue Material

Fatigue Duty cycle

Fatigue 'n' Hotspots

Crack Definition per Hotspot

Crack Growth Analysis



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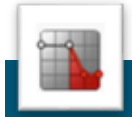
HyperLife

Capabilities

High level

Feature level

Supported Results



Fatigue Modules

Stress Life
+ Safety Factor
+ Static Failure
Strain Life
Weld Fatigue
+ Seam
+ Spot
Vibration
+ Random
+ Sine Sweep
Norm based

Fatigue Material

Database
User Defined
+ XML

Multi – SN curves
+ Mean Stress based
+ Stress Ratio based
+ Haigh

Fatigue loading

Pseudo Static
+ Sequential
Transient
Modal Superposition
Vibration
Random
Sine Sweep

Signal Processing

RPC, DAC, CSV..
Peak Valley slicing
+ Duty cycle
XML format

+ History Output
Stress/ Strain
combined stress
critical plane

Range Envelope

Advance options

Element/Node
Rainflow matrix

Per event contour
Per layer contour

Damage summary csv

Batch
+ Log file
Run Setup file
Sequential scripts (E)

Weld detection

Norm based Fatigue

Auto Weld detection
Weld Classifications
Fatigue strength

Norms
Eurocode 3
DVS 1612 /1608
FKM
ERRI
IEC

Stress Life Approach
Utilization Calculation
Batch evaluation
(Regulations only)

Result Format

.h3d (OS, Permas)
.op2 (OS, Nastran)
.rst (Ansys)
.odb (Abaqus)
.d3plot (LsDyna)
.hdf5 (OS)

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HyperLife Weld Certification

Capabilities

High level

Supported Results

Norm based & Conventional

Weld Detection

Weld Properties

Base Material

Loading

Advance options

Result Format

- Norm based
  - Eurocode 3
  - DVS 1612 /1608
  - FKM
  - ERRI
  - IEC
- Stress Life
  - Damage/ Life
  - Safety Factor

- Auto Weld Detection
- Auto Weld Type

- Evaluation distance
  - Nominal
  - Hotspot
- Weld Properties
  - Templates

- Base metal evaluation
  - Eurocode 3
  - FKM
  - ERRI
  - IEC (Shells)
  - Stress Life

- Stress Life
  - Variable Amplitude
  - Range Envelope
  - Superposition
  - Sequential
  - Gating
  - Utilization
- Norm based
  - Constant Amplitude
  - Fixed Ranges

- Static Assessment
- Utilization report
- Session file

- Batch evaluation (FKM/EC3/DVS)

- OptiStruct
- Nastran
- Abaqus
- Ansys

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HyperLife Crack Growth

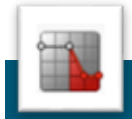
Capabilities

Future scope

High level

Feature level

Supported Results



Crack Growth Modules

- Manual Hotspot
- Auto HotSpot
  eN + CG

Material

- eN
  Database
  User Defined
  + XML
- CG – Total Life

Fatigue Loading

- Pseudo Static

Signal Processing

- RPC, DAC, CSV..
- Duty cycle
  XML format
- Nested Events

Crack Properties

- Hotspot Definition
  + Crack Properties
  + 1D/ 2D
  + Stress Distribution
- Crack Direction
- Mesh Biasing
- Residual Tables
- HotSpot UI Updates

Advance Options

- Single/ Multiple Hotspots
- Session files
- Run Setup File XML
- Batch Evaluation
- Performance
- Multiple Result input
- Per Event results
- Max/ Min Stress

Result Format

.h3d (OS)

.rst (Ansys)
.odb (Abaqus)

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Thank you

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