

## PSD Fatigue – Fatigue Analysis in the Frequency Domain

Loading due to actions such as vibration, wind motion or wave motion is often characterised in the frequency domain rather than in the time domain. This avoids generating extremely large time histories which can have the problem of being both computationally expensive and time consuming. In the frequency domain Fourier transforms are used to obtain Power Spectral Density (PSD) profiles.

Fatigue analysis of structures subjected to these profiles can be performed using several techniques, the most commonly accepted being that proposed by Dirlik.

Jesmond Engineering’s PSD-Fatigue software uses a power spectral density function in combination with material fatigue characteristics and Dirlik’s equations to calculate fatigue life.

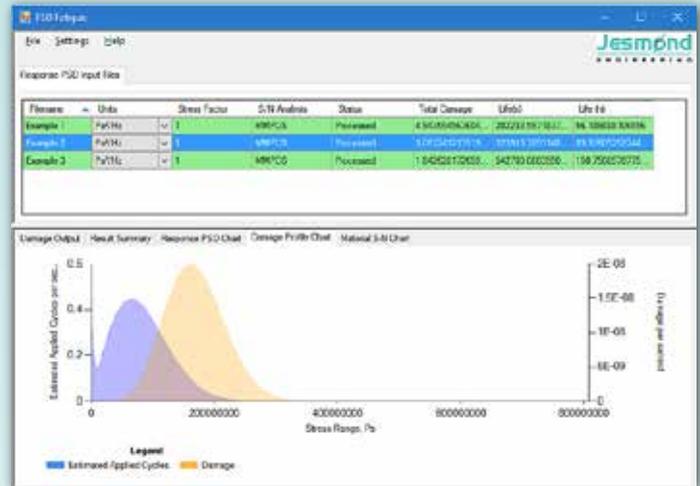


Figure 1 Example PSD-Fatigue results showing calculated lives and distributions of damage and loading

## HUMS – Aircraft Health Usage Monitoring System

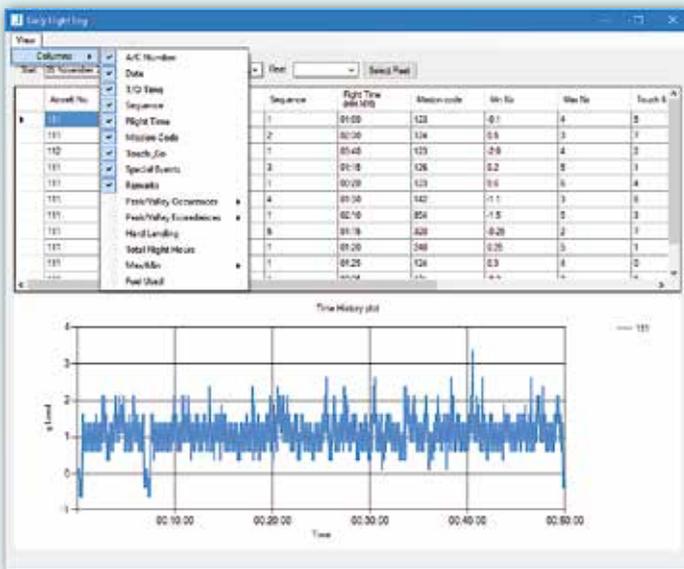


Figure 2 Example HUMS fatigue monitoring software, showing a fleet flight log

It is in an aircraft operator’s interest to ensure that an aircraft fleet remains safely operational for as long as possible. It is therefore critical to know how much of the fatigue life of each aircraft has been consumed, so that aircraft can be retired at the correct time.

Individual aircraft within the fleet may perform different roles and accumulate fatigue damage at different rates. For this reason the roles of each aircraft in the fleet are normally continually managed such that overall, each aircraft accrues a similar amount of fatigue damage.

To help track the estimated fatigue based on usage, Jesmond Engineering provides monitoring software which analyses supplied flight data and provides details of the fatigue damage accrued per flight, and the predicted remaining life of each aircraft.

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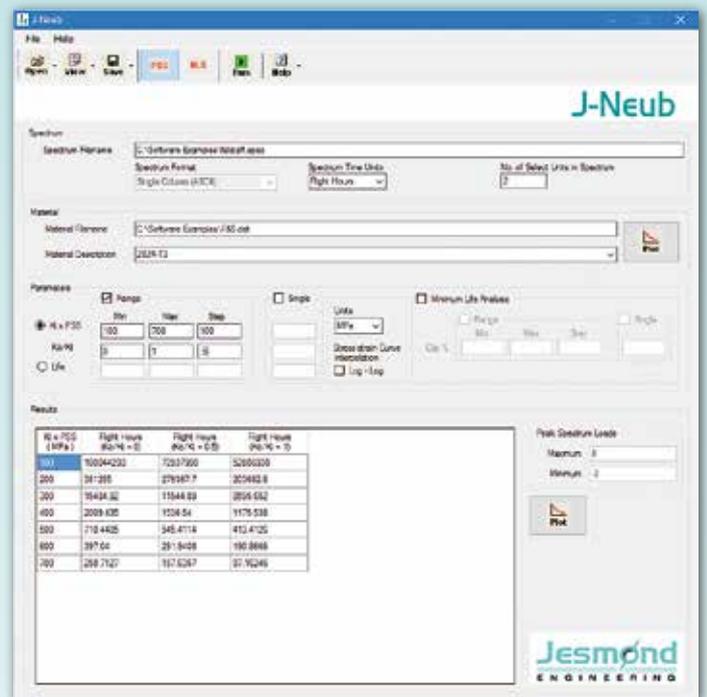
## J-Neub – Local Strain-Based Fatigue Analysis

J-Neub has been written utilising over 25 years' experience in using local strain-based methods to estimate fatigue crack initiation life of major structural components.

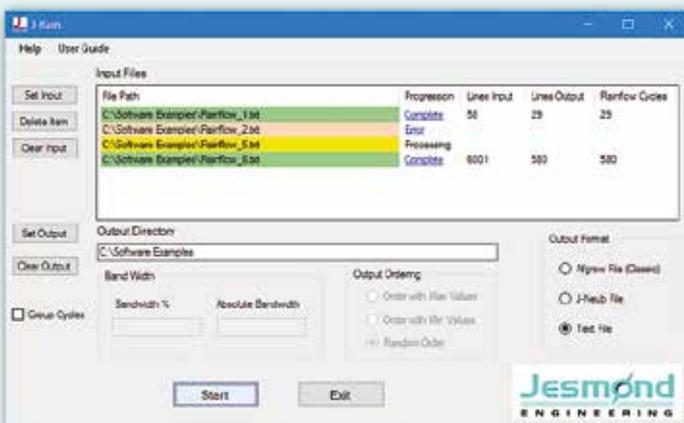
The program uses Neuber's rule to calculate the local stress and strain at a notch root due to externally applied elastic loads combined with an elastic stress concentration factor.

The stress-strain behaviour is tracked at the notch during the application of a spectrum of external elastic loads and the fatigue life is estimated using the Palmgren-Miner rule of linear accumulation of damage based on the closure of individual hysteresis loops.

**Figure 3** Example J-Neub fatigue analysis (right)



## J-Rain – Cycle Counting Software



**Figure 4** Example multi-threaded J-Rain run, with input file validation

The load histories applied to components such as an aircraft wing, a car suspension or an oil rig structure are irregular in nature, whereas fatigue coupon test data are usually obtained from constant amplitude loading.

In order to use test data for fatigue analysis of irregular load histories, the cycles must be extracted. There are several methods to extract cycles but the best ones recognise that due to hysteresis effects the cycle between the highest peak and lowest valley in the spectrum are combined. The most commonly used methods in industry are range-mean-pair and rainflow, which produce equivalent results if done properly.

Using J-Rain it is possible to process multiple variable amplitude spectra and retrieve cycle-counted results.