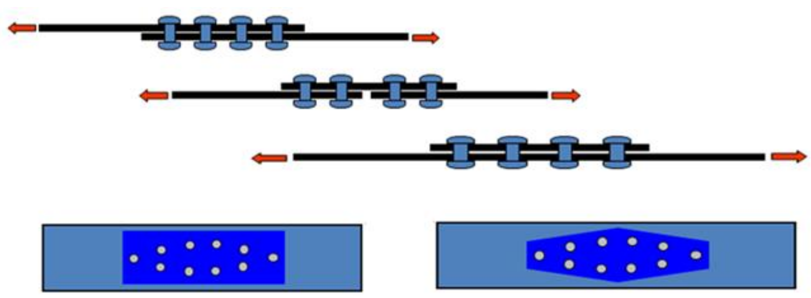
MULTI-FASTENER ANALYSIS TOOL

Smart Application: Multi-Fastener Analysis Tool

MFAT expands and complements the analysis capabilities of SFAT to analyze joints with more than one fastener. It provides accurate computation of load transfer among fasteners, as well as plate stresses, for single and double shear lap joints, splice joints and doublers with any number of fasteners. To obtain these results, a 2D-contact analysis is performed with StressCheck®.

MFAT Highlights

MFAT provides effortless modeling of **single or double shear joints**, including **lap joints, splice joints, and doublers** (with or without a repair cutout). MFAT supports **metallic** and **composite** plates, and allows for any number of fasteners with neat fit, interference fit or clearance fit. MFAT accounts for both the radial stiffness of the fastener and the fastener fit, including the nonlinear interaction between the fastener shank and the fastener hole. MFAT also includes the effect of the shear/bending stiffness of each fastener, the value of which can be accurately computed with SFAT. The FE mesh is built 'on the fly' based on input provided by the user in a very intuitive interface. Fastener load transfer results obtained with MFAT are presented in tabular form and depicted graphically, and they compare well with experimental data published in the literature.



MFAT Results

MFAT computes the fastener loads, the maximum first principal stress, and the von Mises stress around each hole of each plate in the joint. Convergence information is provided for these quantities to assess **the reliability of results**. An interactive 3D viewer displays deformation and stress contour plots which can be dynamically manipulated by the user. All models and solutions created by MFAT can be exported as StressCheck files for further analysis.

"MFAT allows the analyst to determine the distribution of loads in a complex joint accurately, with no assumptions. The interface provides a variety of structural configurations quickly with minimal data entry. A user inexperienced in finite element methods can obtain a state-of-the-art, converged, FEM solution reliably in a matter of moments. Quality, accuracy, speed…it doesn't get any better."

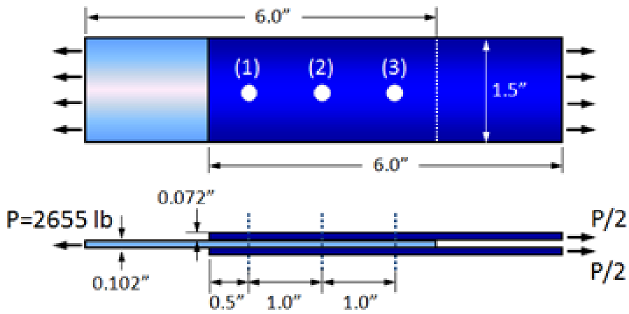
Dr. Herb Smith
Boeing Research and Technology

Key Benefits

- Simulate influence of fastener fit in load transfer.
- Solution time is reduced from **hours to minutes** when compared with standard FEA.
- Simplified user interface provides input of fastener data in pre-defined templates with step by step validation feedback.
- Solutions are obtained with StressCheck, with **quality verified** by p-extension.
- Modeling approach validated with experimental results.
- Built-in results viewer provides dynamic viewing of FE mesh and stress fringe contours.

MFAT Validation Using Experimental Results

A symmetric double lap splice joint with three aluminum plates mechanically joined by three protruding head steel bolts and loaded with P=2655 lb was tested by McCombs*. The fastener loads computed with MFAT for the central plate (F1=975, F2=821, F3=859) compare well with the experimental values reported by McCombs for specimen II-D (F1=1016, F2=880, F3=765). As stated by McCombs, "... even though the holes were reamed to achieve sliding fitting, some small clearance was present in some of the holes". To investigate the effect of clearance in the load transfer, the problem was solved again with MFAT including a larger hole diameter (a clearance of 0.001") for fastener location 3 in the 0.102"-thick plate. With this modification, the fastener loads computed with MFAT (F1=1011, F2=873, F3=772) are in closer agreement with the experimental results. This clearly shows the influence of fastener clearance in the load transfer of multi-fastener joints and shows how simple it is to study the influence of fastener fit using MFAT.



Case	Fastener Load [lb]			Fast. Stiff. [lb/in]	Fast. Clearance 1 / 2 / 3 [in]
	F1	F2	F3		
Analytical†	1000	782	872	800,000	0.0 / 0.0 / 0.0
MFAT – Neat Fit	975	821	859	217,000	0.0 / 0.0 / 0.0
MFAT – Clearance	1011	873	772	217,000	0.0 / 0.0 / 0.001
Test†	1016	880	765	--	Unknown*

* AFFDL-TR-67-184, Analytical Design Methods for Aircraft Structural Joints, McCombs, McQueen & Perry (1968).

Deployment Options

MFAT is available as a StressCheck module or as a stand-alone 64 bit application accessible through the StressCheck Tool Box (SCTB) framework. A complete developer's API is included with the MFAT installation for automation and custom .NET application development.

SCTB deploys FEA-based Smart Applications for the analysis of structural details such as single and multiple fastener joints or laminated composite plates. Each Smart App provides convergence information to ascertain the quality of the numerical solution obtained with StressCheck.