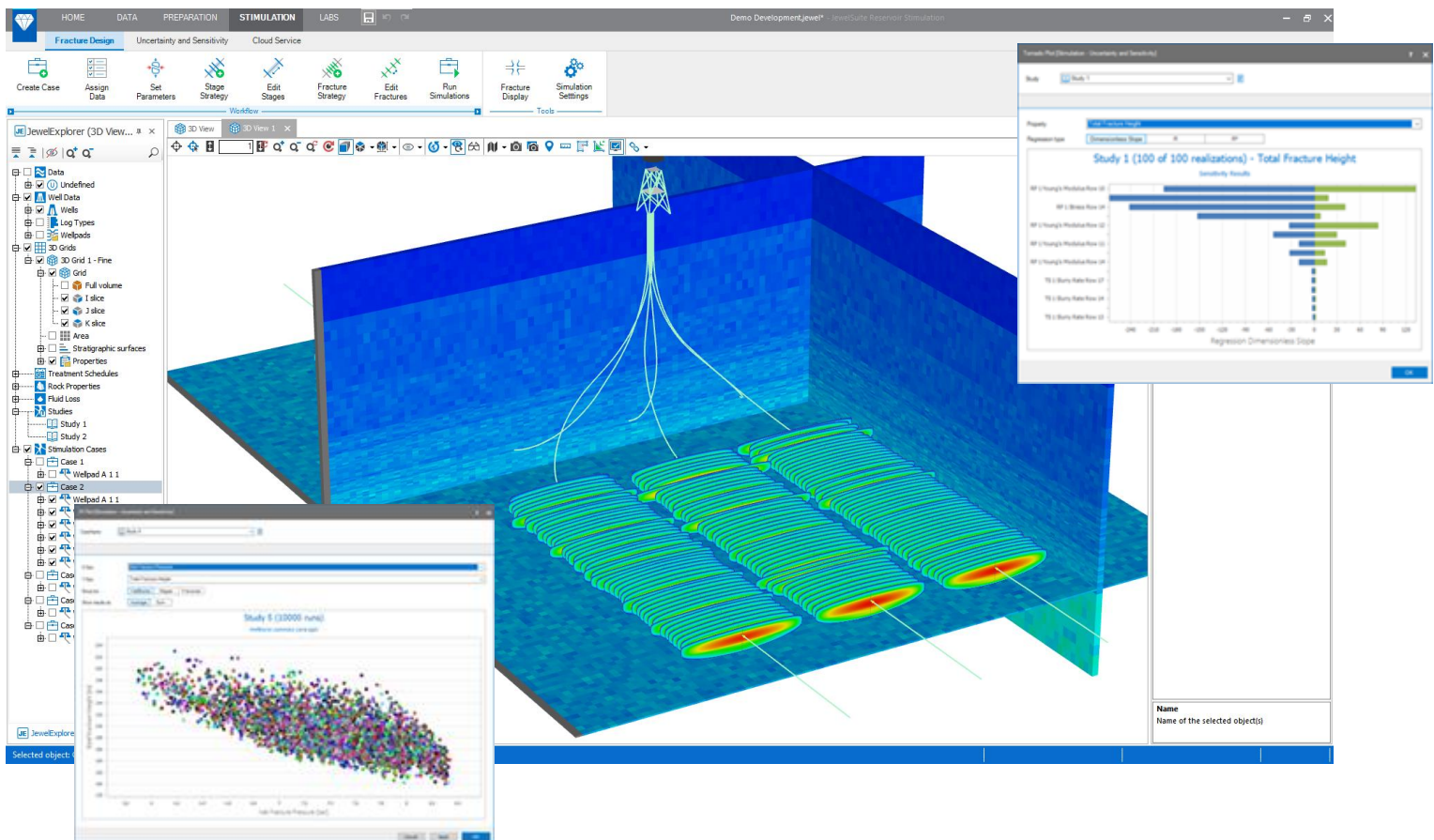


# JewelSuite™ Reservoir Stimulation & MFrac™ Suite

Frac Design and Analysis



# Pioneering Frac Designs

Our hydraulic fracturing design and analysis software enables you to target the most productive zones, determine effective fracture treatments, and monitor reservoir stimulation in real-time. Our software has supported engineers since the early days of frac modeling. Now, we are delivering a step-change in efficiency and capability for people who are responsible for unconventional well planning, stimulation modeling, frac execution and production forecast-based economic decisions.

MFrac Suite software enables you to create and execute efficient well stimulation designs in both conventional and unconventional plays to maximize production and extend the life of your well. By managing your planning process more effectively and integrating real-time data, minifrac, hydraulic fracturing, well production and economics, you gain confidence in your treatment plan and arrive at more meaningful reserves estimates.

JewelSuite software delivers subsurface intelligence and insight through a portfolio of applications focused on geological modeling, geomechanics, hydraulic fracturing, reservoir simulation and visualization to optimize field development plans and drive greater production. The JewelSuite™ Reservoir Stimulation application enables you to quickly identify the optimum stimulation strategy for multiple stages along multiple wells, to execute sensitivity and uncertainty studies, and to export results to industry-standard reservoir flow simulators.

MFrac Suite and JewelSuite™ Reservoir Stimulation application are available in English, Russian, and simplified Chinese editions.

Optimize your hydraulic fracturing designs for wells and well pads in unconventional fields

Multi-stage & multi-well capabilities

Quickly simulate all stages along the laterals

Consider stress shadowing between stages and wells

Manage case & scenarios in one solution

Utilize patent-pending, data-driven stage and cluster placement advisor

Visualize all relevant subsurface data in 3D

Uncertainty & sensitivity analysis workflows

Seamless integration with larger upstream workflow

Export results to major flow simulators

# Hydraulic Fracturing Software at Baker Hughes

## MFrac Suite Hydraulic Fracturing Software

MFrac Suite hydraulic fracturing software is field proven and trusted. It makes it easy to design your treatment plan using established engineering design principles to increase your recovery, target your most productive plays while avoiding trouble zones, and optimize your treatment schedules.

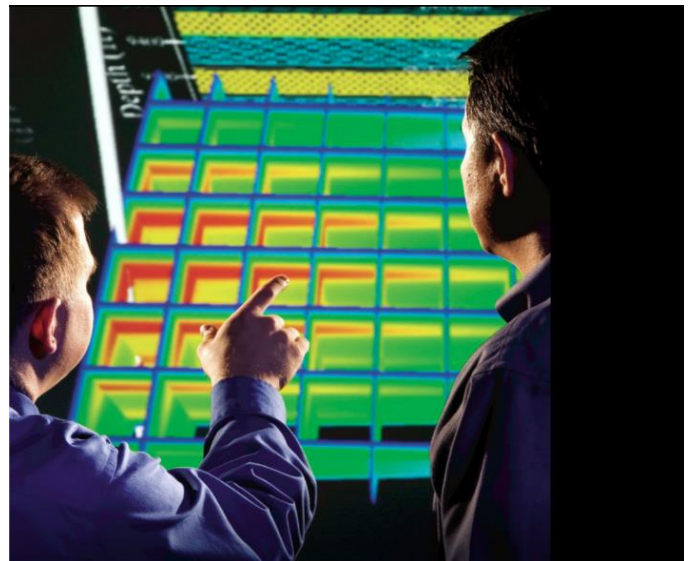
For more than 25 years, engineers have trusted MFrac Suite software to provide reliable hydraulic fracturing predictions for enhanced investment decisions, better well placements, optimized stimulation treatments, and increased ultimate recovery.

## Design and Evaluation Simulator

The comprehensive MFrac™ hydraulic fracturing 3D design and evaluation simulator offers a wide variety of options including 3D fracture geometry and auto design features as well as integrated proppant, acid and foam treatment solutions. The fully coupled proppant transport and heat transfer routines, together with a flexible user interface and object-oriented development approach, enable you to easily use the program for fracture design, treatment analysis, and parametric analyses. With a fully incorporated log analysis module, generate rock properties from logs such as Gamma Ray, Neutron and Sonic using various correlations for more accurate fracture design.

## Discrete Fracture Network (DFN) Simulator

The MShale™ simulator predicts fracture propagation and its extent in fractured and naturally fractured reservoirs. The program offers user-specified DFN characteristics where the fracture network spacing, aperture, and aspect ratios are input and deterministic DFN characteristics where the stress differences (i.e.,  $\sigma_2 - \sigma_3$  and  $\sigma_1 - \sigma_3$ ) and network properties are input. Proppant transport also is unique: the proppant distribution can be uniform, all in the dominant fracture, or calculated according to a user-specified minimum allocation in the dominant x-z fracture plane.



## MiniFrac Design and Analysis

The MinFrac™ minifrac diagnostic tool implements the latest fracture-injection and pressure decline theory. Use the results of minifrac analysis to derive hydraulic fracturing and reservoir characteristics, and to design and refine your primary hydraulic fracturing treatment. MinFrac can be used for pump-in/shut-in, step-rate and pressure-decline analysis, along with history matching of geomechanical properties.

## Real-Time Data Management

The MView™ real-time data management application is simple and reliable. Its flexible structure enables you to use the application as a general data management system. MView allows you to share real-time data or replay the dataset with the MinFrac™ minifrac application, the MFrac™ hydraulic fracturing simulator, the MShale™ natural fractures simulator, the MFrac- Lite™ hydraulic fracturing simulator, and the MWell™ wellbore hydraulics simulator for use as simulation input. These data can include pump rates, bottomhole and surface pressures, proppant concentrations, and nitrogen or carbon dioxide injection rates versus time.

## Produced-Water ReInjection Simulator

Our MPwri™ produced-water reinjection simulator is used for predicting hydraulic fracture pressure and geometry associated with produced-water reinjection and water flooding. The application was specifically designed for evaluating the effects of injecting large volumes of fluid over long periods of time with fracture efficiencies approaching zero. Major features include: 1) thermal and poroelastic stresses, 2) layered thermal and water fronts, and 3) numerous internal and external filtration resistance mechanisms.



## Wellbore Hydraulics Simulator

The MWell™ wellbore hydraulics simulator calculates surface and/or bottomhole pressures, gravitational head, restrictions, transport times, and hydraulic power requirements in the wellbore. Near-wellbore and perforation pressure losses can also be calculated to determine the bottomhole treating pressure in the formation. The application was designed for real-time analysis to calculate bottomhole treating pressure from surface conditions. You can also use the application as a design tool for determining wellbore pressure characteristics prior to treatment.





## Production Modeling

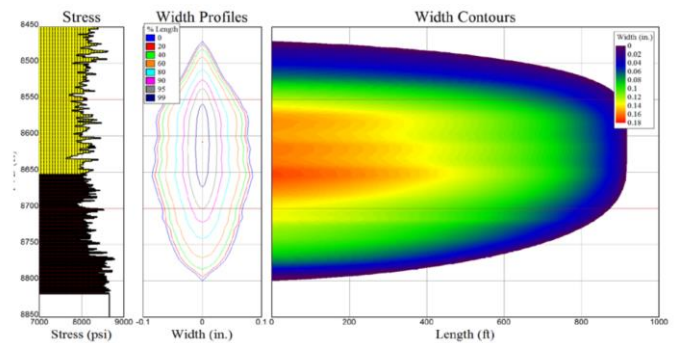
MProd™ is a single-phase analytical production modeling application that assesses the production for a variety of treatment scenarios using a comparison with unfractured wells. With data imported from our MFrac™ design and evaluation simulator, the MProd numerical results are used by our MNpv™ application for forecasting the fractured well's net present value or return on investment. This application enables you to simultaneously simulate reservoirs with different fracture lengths to determine optimum fracture geometries.

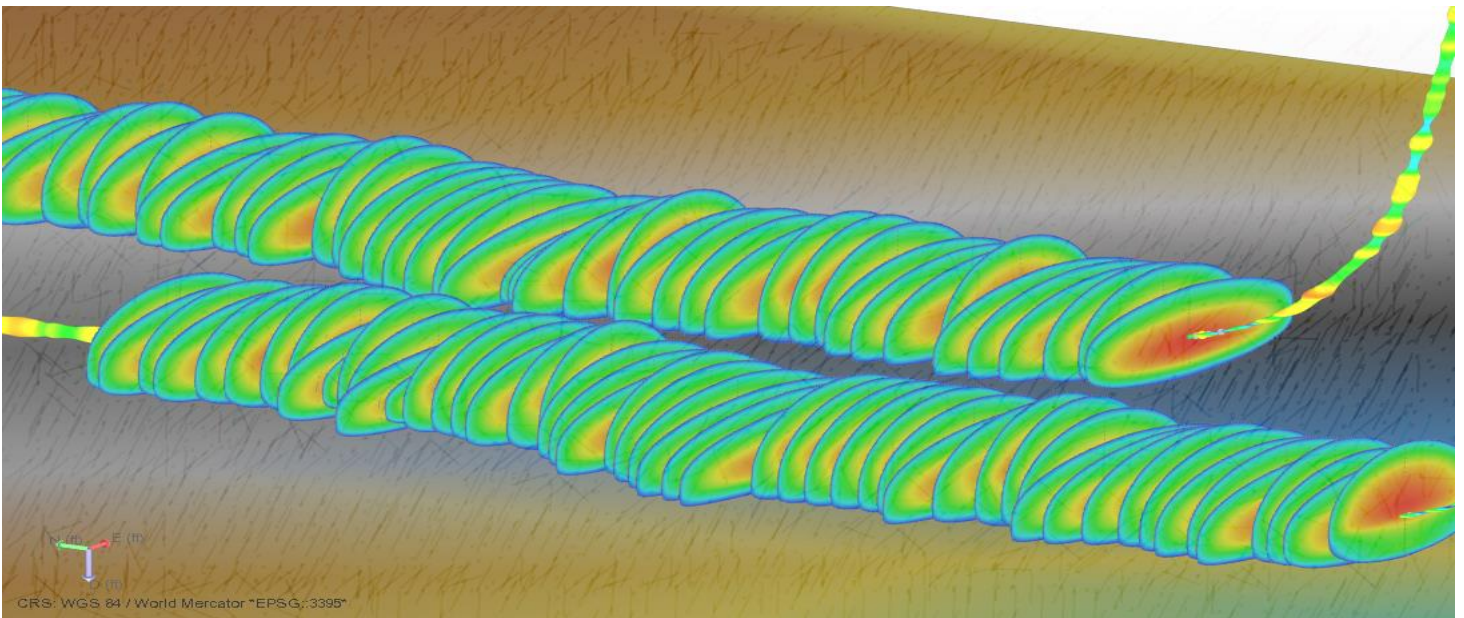
## Forecasts NPV and ROI

MNpv™ economic treatment optimization compares the revenue benefits and cost penalties associated with your operations. As a result, you can maximize stimulation profitability and optimize hydraulic fracture conductivity and length. In particular, it forecasts the net present value (NPV) and return on investment (ROI) of your stimulated wells. With MNpv software, you can manage your planning process more effectively to improve the economics of your stimulation treatment.

## 2D Fracturing Simulator

Our easy-to-use MFast™ analytical 2Dfracturing simulator for Geertsma-de Klerk (GDK), Perkins-Kern/Nordgren (PKN), and ellipsoidal geometries performs parametric and model comparison studies quickly. The methodology used in the MFast simulator is comparable to a lumped analogy: The simulator uses constant coefficients derived from our MFrac™ design and evaluation simulator, applying steady boundary conditions in a homogeneous formation.





## Optimized stimulation design workflow

The multi-stage modeling workflow leads you from import of all relevant data, via case management and fracture stage placement to setting up simulations with stimulation designs and treatments populated along a well. All stages along a well can be modeled in one go with our industry-trusted hydraulic fracturing simulator, MFrac™. The effects of stress shadowing for multiple stages are computed for sequential and alternating staging as desired. Informed decisions can be made concerning well spacing, well placement, landing zone, stage spacing, stimulation method, fracturing fluids and proppants, treatment rates and volumes, and hazard avoidance

## Cluster placement advisor

Geometric stage and cluster spacing is often the most practical solution, in particular when you are planning stage and cluster placement in the absence of data. However, when you want to leverage logs to optimize stage and cluster spacing, you can turn to our patent-pending technology with the data-driven placement advisor, which provides the optimal stage and cluster placement strategy with a few clicks within the stimulation design workflow.

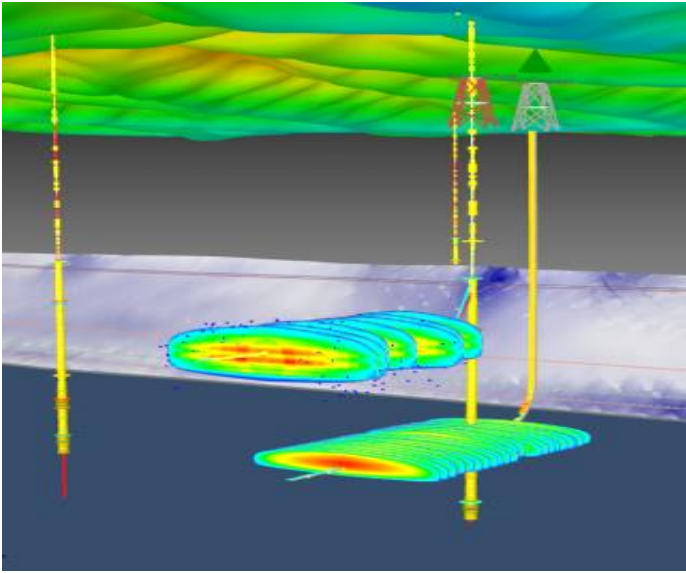
## Stress shadowing effects

Fractures placed in close proximity can interfere with each other mechanically and increase required treatment pressures. Predicting and mitigating the effects of these stress shadows, or using them to your advantage, can make a significant difference in the success of your stimulation program.

With JewelSuite Reservoir Stimulation, stress shadowing effects can be taken into account during the simulation of hydraulic fractures across multiple wells. The stress shadowing calculations are based on peer-reviewed, published analytical solutions that have been validated by industry-leading 3D finite-element models. These tools assist you in identifying the optimal distance between fracture stages and, ultimately, in designing the best stimulation design for the entire well or well pad.

## Multiple wells with multiple stages

Model different treatment schedules, rock properties, perforation zones and fluid losses for each stage across multiple wells, or model several stages identically with variations derived from log data. Export fracture results in reservoir simulator format – select specific stages, whole wells or complete cases.



## Embracing uncertainty

Execute uncertainty and sensitivity studies to identify the most important changeable parameters and to quantify the probability of success resulting from uncertainty in material or other parameters. Utilize a patent-pending mini-language to describe uncertainty parameters in a concise form and choose from different sampling strategies.

Analyze your results with tornado, percentile and scatter plots and export study inputs and results into CSV file format, including individual fracture results and summary results per stage or realization. Also, extract realizations as independent cases and visualize them in the 3D view along with other subsurface objects and fracture design workflow cases.

## Flexibility, connectivity, and extensibility

The JewelSuite Reservoir Stimulation application is built on the JewelEarth™ development platform that enables you to easily enhance existing functionality with new plug-ins or modules that contain your own algorithms or methodology; build your own workflows; and connect to proprietary databases or other subsurface applications by using the JewelEarth Software Development Kit (SDK).

## Improved efficiency and ease of use

You can accelerate your workflow and reduce errors using several key features included in JewelSuite Reservoir Stimulation. Import your existing MFrac files and leverage existing well and log data, treatment schedules, rock properties, perforation zones and fluid loss tables. Work seamlessly with existing MFrac fluid and proppant databases or select a custom user database.

JewelSuite Reservoir Stimulation has built-in case management and manages different scenarios, wells, logs and designs all within one solution file, so you can focus on optimizing the stimulation plan with consistent data rather than spending time with data import, export and file management.

