

Kinematic Interactivity

Interactivity controls have been introduced in the 2D and 3D Kinematic Modelling Modules in Move™ to make them easier to use and to improve the user experience. Minimising the number of mouse clicks and adding the ability to preview the outcome of computationally intensive workflow steps enhances usability and efficiency for the user. With this, less time is spent adjusting and implementing the workflow, allowing more time to be spent interrogating and interpreting the results, with clear time and cost benefits. If initial modelling must be re-run, the benefits of this increased efficiency are multiplied. In this article, the interactive features available in the 2D and 3D Kinematic Modelling modules are highlighted.

Horizons from Fault

When undertaking 2D forward modelling using the **Horizons from Fault** tool, it is possible to interactively manipulate the following input parameters in the **Section View**: the basement level, fault geometry, horizon thickness, and displacement of each horizon (Figure 1). With the exception of selecting the kinematic algorithm to be applied, and collecting the fault into the toolbox, a **Horizons from Fault** construction can be completed entirely from within a Section View. These improvements in the **Horizons from Fault** tool facilitates quick sensitivity testing of the effects of different kinematic algorithms on predicted horizon shape, allowing fast validation of an interpretation, and helps find the most appropriate parameters to be used during a sequential restoration. These benefits save considerable time later in the structural analysis workflow.

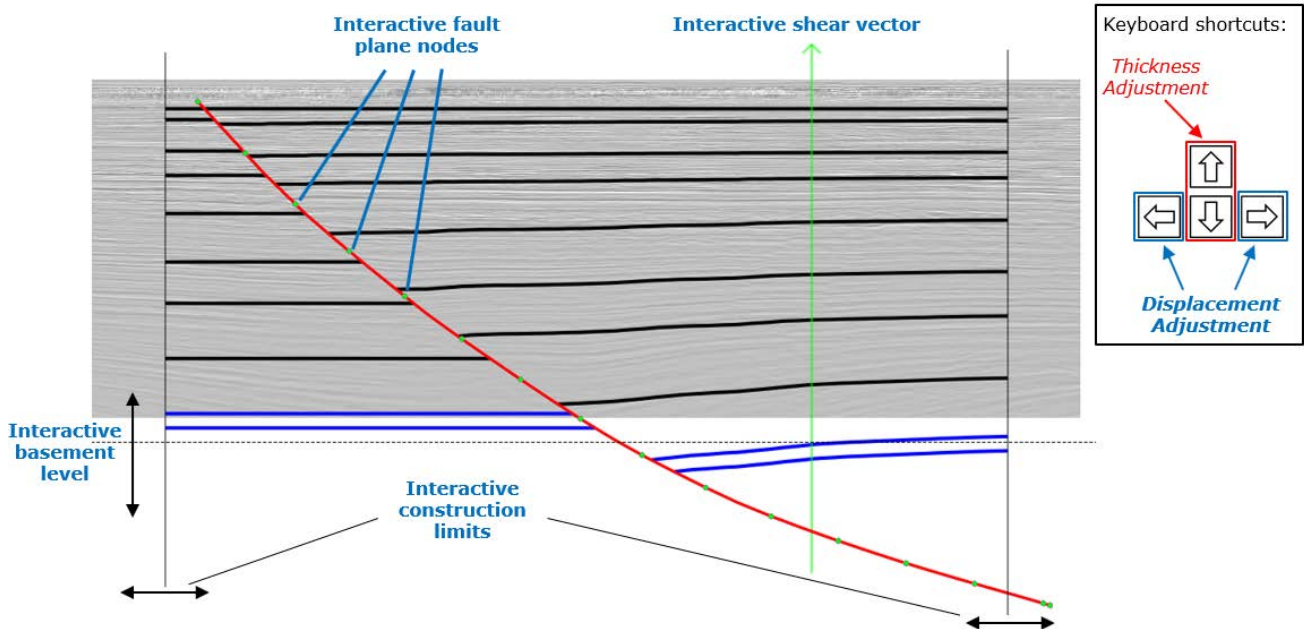


Figure 1. Predicted horizon geometries associated with vertical simple shear deformation of a normal fault using the Horizons from Fault tool. Interactive features available in the Horizons from Fault tool are annotated. Data from Triezenberg et al. (2016).

Auto-population

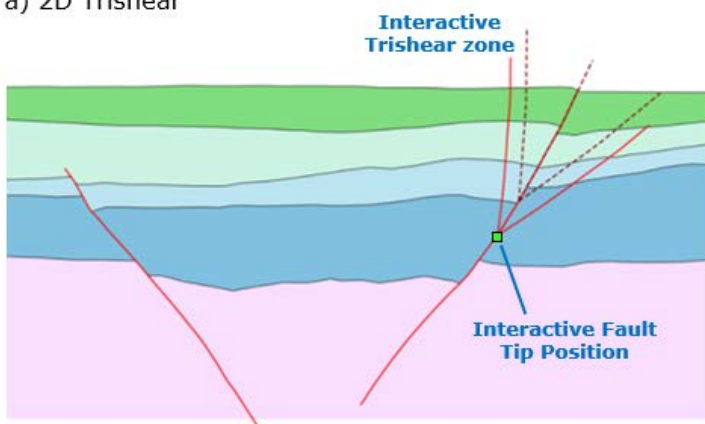
Objects to be used in a **Move-on-Fault** or **Decompaction** calculation can now be automatically collected (auto-populated) into the toolboxes. To do this, all objects that are to be involved in the calculation are required to be selected in the model / Model Browser prior to opening the toolbox. This will result in the objects such as the **Fault**, **Objects to be Moved**, **Top Beds**, **Active Intermediate Objects** and **Base Beds** to be auto-populated into the appropriate boxes when the tool is opened. This functionality is available in both the **Decompaction** and **Move-on-Fault** tools in the 2D and 3D Kinematic Modelling modules.

In addition to auto-population, the **Decompaction** and **Thermal Subsidence** toolboxes will automatically update once a horizon is removed from the model during decompaction. Once the youngest horizon is removed, the next youngest horizon will automatically be transferred from the **Active Intermediate Objects** box to the **Top Beds** box in the **Decompaction** toolbox and from the **Passive Beds** to the **Top Horizon** box in the **Thermal Subsidence** toolbox in preparation for the next stage of the workflow. This auto-update means that once the parameters in the **Decompaction** and **Thermal Subsidence** toolboxes are defined at the start of a restoration, and a stratigraphy has been set up, performing repeated **Decompaction** and **Thermal Subsidence** steps can be completed easily, simply by returning to the toolboxes and clicking **Decompact** or **Apply**.

Move-on-Fault

While restoring fault-related deformation in 2D, it is now possible to interactively adjust several input parameters in a Section View. The **Shear Angle** can be adjusted using the interactive shear vector handles for the Simple Shear method. For the Trishear algorithm, the **Trishear Angle**, **Trishear Angle Offset**, and **Fault Tip Position** of the trishear apex can all be adjusted interactively in a Section View (Figure 2a). For the Elliptical Fault Flow algorithm, which is a new Move-on-Fault algorithm developed by Midland Valley (see May 2017 Move Feature), it is possible to adjust parameters including **Displacement Centre** and **Displacement Extents**. The interactivity associated with each algorithm in the **2D Move-on-Fault** tool is also available in the **Horizons from Fault** tool. In the **3D Move-on-Fault** tool, an interactive transport plane is available for all algorithms (Figure 2b).

a) 2D Trishear



b) 3D Move-on-Fault

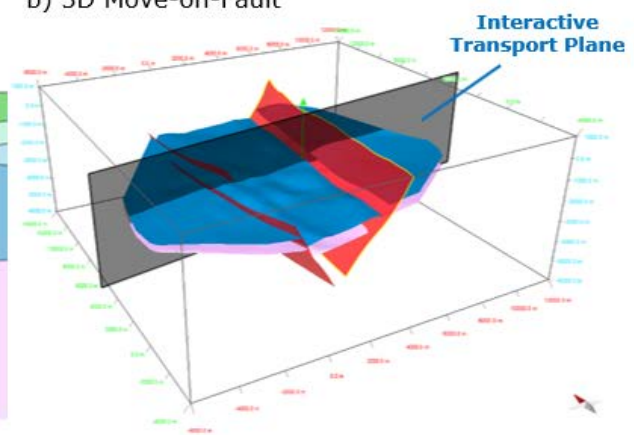


Figure 2. a) Restoration of a fault in 2D using the Trishear algorithm. Interactive parameters are annotated. b) For all 3D Move-on-Fault algorithms a transport plane can be adjusted in 3D.

Unfolding

While performing 2D unfolding operations, interactive shear angles and pins are now available in Section View for Simple Shear and Flexural Slip Unfolding methods respectively (Figure 3a). Independent of the unfolding method used, the **2D Unfolding** toolbox has an interactive horizontal datum that can be positioned and sized in the Section View when using the **Unfold to Datum** method.

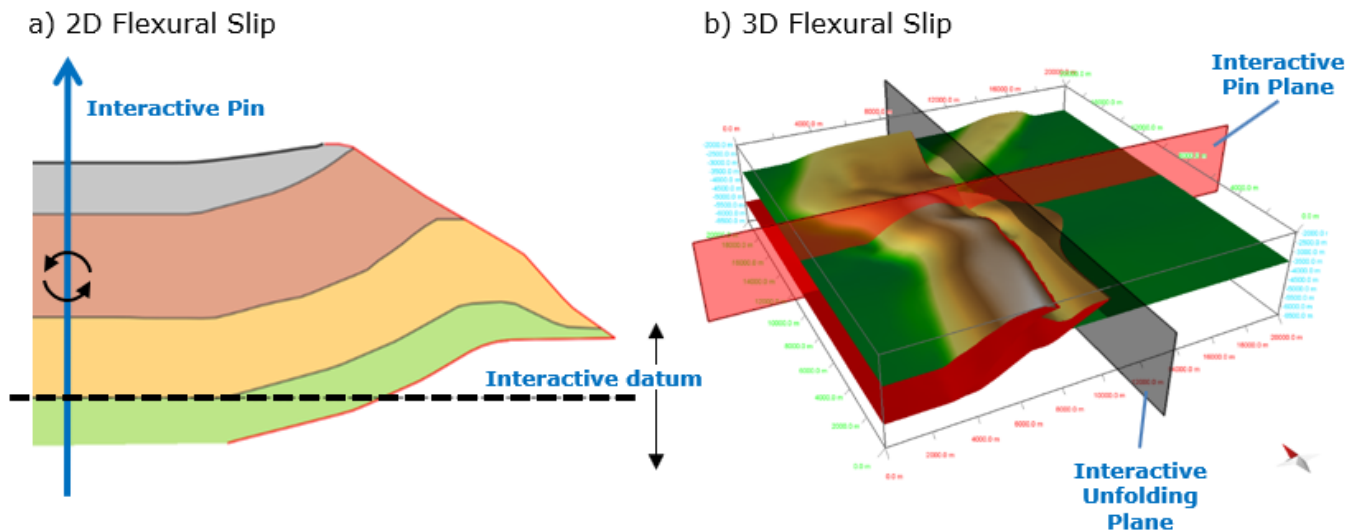



Figure 3. Interactive features available for Flexural Slip unfolding in (a) 2D and (b) 3D.

Next to the **Datum** definition box there is a new radio button . When selected, this radio button will automatically position the interactive pin or shear arrow and the horizontal datum (if applicable) in the centre of the template bed.

In 3D, interactive pin and unfolding planes are available for Flexural Slip restorations (Figure 3b). The position and orientation of these planes can be automatically calculated from the shape of the template bed using the **Calculate Unfolding Directions** and **Set Unfolding Positions To** options.

The increased efficiency, which results from the interactivity available in the 2D and 3D Unfolding tools, is most valuable in analyses where unfolding is common and repetitive, such as geometrical restorations. The interactive options make each unfolding operation faster, which combines into a substantial time saving over the course of a full restoration.

Preview mode

In the **2D Move-on-Fault**, **2D Unfolding**, and **Thermal Subsidence** toolboxes, a pre-execution visualization of the results is available using the **Preview Mode** option, situated beside the **Apply** button at the base of the toolbox (Figure 4). This allows the user to perform a quick quality check (QC) of the results without applying the workflow step, which can be time consuming and computationally intensive when the seismic image is being carried with the modelling operation. If the results are unsatisfactory, the user can adjust the input parameters and automatically preview the results. The preview mode is faster when sensitivity testing parameters (e.g. shear angles or pin positions; Figure 4), and is a valuable check of the effects of input parameters prior to all **Move-on-Fault**, **Unfolding**, and **Thermal Subsidence** operations. **Preview Mode** is only available in 2D for Move-on-Fault and Unfolding, and is available in 2D and 3D for Thermal Subsidence.

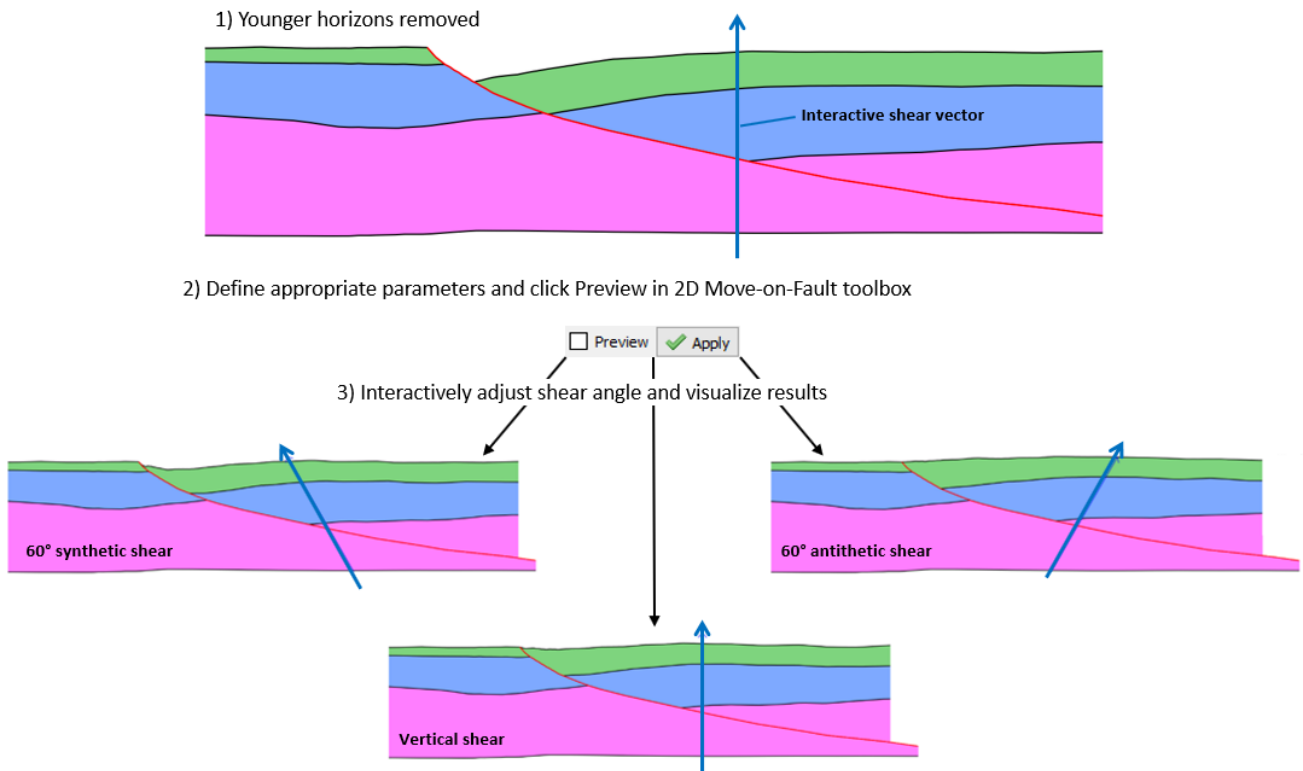


Figure 4. Sensitivity testing of shear angle in a Simple Shear 2D Move-on-Fault operation using the Preview Mode. Once Preview Mode is selected, interactive adjustment of the shear angle will result in automatic visualization of the results, allowing quick evaluation of unknown parameters.

Summary

Interactivity in Move enhances efficiency by reducing the number of mouse clicks required to perform common operations and by providing immediate visual feedback. The reduction in mouse clicks and improvements made to visualization capability makes defining input parameters in the tools significantly faster and the preview functionality allows quick validation of data and parameters. Additionally, faster use of the tools through interactivity means that more scenarios can be tested, or multiple iterations of restorations can be accomplished, allowing a more exhaustive structural analysis to be completed within the same timeframe. This maximises the benefits associated with a structural analysis and saves both time and cost, for example, when analysing long 2D cross-sections incorporating high-resolution seismic data.

References

Triezenberg, P. J., Hart, P. E., and Childs, J. R., 2016, National Archive of Marine Seismic Surveys (NAMSS): A USGS data website of marine seismic reflection data within the U.S. Exclusive Economic Zone (EEZ): U.S. Geological Survey Data Release, doi: 10.5066/F7930R7P.

If you require any more information about **Kinematic Modelling** or other workflows in **Move**, then please contact us by email: enquiries@mve.com or call: +44 (0)141 332 2681.