We use the current interplanetary type II theory and a data-driven solar wind model to simulate dynamic spectra of type II bursts. An iterative downhill simplex method is used, to compare observed and predicted dynamic spectra to extract the time-varying shock parameters. The simplex method quantitatively assesses and improves the agreement using two performance metrics; the first based on the correlation function and the second on the normalized difference. We are able to extract the input model shock parameters to within 30% or better when using artificial model solar winds of increasing complexity. Using a realistic solar wind model, parameters are recovered generally to within a few percent. We then quantitatively compare the theory with observations and extract the shock parameters for three well observed type II events. We first obtain good qualitative and semi-quantitative agreement (40-50% correlations and small time and frequency offsets) between the predicted and observed dynamic spectra using independent shock estimates from CME data. The iterative method then extracts model shock parameters that increase the agreement between theory and observation in terms of relative flux levels, spectral intensifications, and drift rates. The shock parameters agree qualitatively and semi-quantitatively with those estimated from CME observations for two events. Quantitatively, the simulated radio emission is typically overpredicted for each event by around 5 dB. The theory and methods show great potential for space weather prediction and remote inference of CME-driven shock parameters.