This work deals with an efficient and robust technique of performing Boolean operations on polygonal models. Full robustness is achieved within an internal representation based on planes and BSP (binary space partitioning) trees, in which operations can be carried out exactly in mere fixed precision arithmetic. Necessary conversions from the usual representation to the inner one and back, including their consequences are analyzed in detail. The performance of the method is optimized by a localization scheme in the form of an adaptive octree. The resulting implementation RazeCSG is experimentally compared with implementations used in practice Carve and Maya, which are not fully robust. For large models, RazeCSG shows only twice lower performance in the worst case than Carve, and is at least 130 times faster than Maya.