CAD/CAM approaches have been used in the manufacturing industry for a long time, and their use in robotic systems is becoming more popular. One common element in these approaches is the use of geometric constraints to define relative object poses. Hence, approaches for solving these geometric constraints are critical to their performance. In this work, we present an exact solver for geometric constraints. Our approach is based on mathematical models of constraints and geometric properties of constraint nullspaces. Our constraint solver supports non-linear constraints with inequalities, and also mixed transformation manifolds, i.e., cases where the rotation and translation components of the constraints are not independent. Through several applications, we show how inequality constraints and mixed transformation manifolds increase the expressive power of constraint-based task definitions. The exact solver provides repeatable solutions with deterministic runtimes and our experiments show that it is also much faster than comparable iterative solvers.