In this paper, we propose a framework for intuitive task-based programming of robots using geometric inter-relational constraints. The intended applications of this framework are robot programming interfaces that use semantically rich task descriptions, allow intuitive (re-)programming, and are suitable for non-expert users typically found in SMEs. A key concept in this work is the use of CAD semantics to represent geometric entities in the robotic workcell. The robot tasks are then represented as a set of geometrical inter-relational constraints, which are solved in real-time to be executed on the robot. Since these constraints often specify the target pose only partially, the robot can be controlled to move in the constraints' null space in order to handle external disturbances or further optimize the robot's pose during runtime. Geometrical inter-relational constraints are easy to understand and can be intuitively specified using CAD software. A number of applications common in industrial robotic scenarios have been chosen to highlight the advantages of the presented approach vis-à-vis the state-of-the-art approaches.