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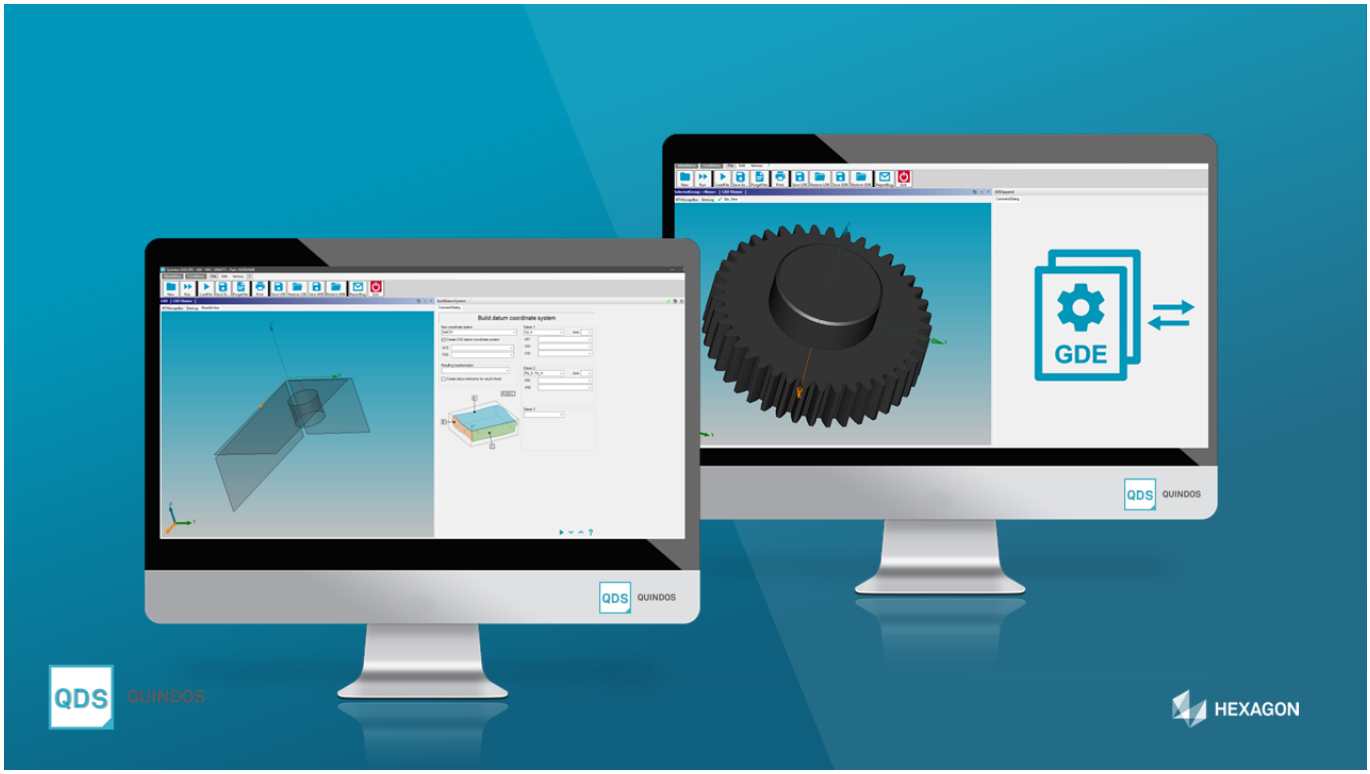

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One of the more serious errors that can occur with multibody dynamics simulations is the lack of properly specified boundary conditions (i.e., contact constraints) [@khatib2003chapter]. When contact constraints are not given, it can result in such artifacts as damage to the object being modelled and when it is being tested [@coumans2003contact]. A common solution is to simulate with no contact constraints, an approach called *passive-elastic* multibody dynamics simulation. In this method, objects are thought to be made up of a number of rigidly connected components, with each component described by its geometric properties, such as the mass, stiffness and damping properties of the body, as well as the radius of gyration (ROG) and moment of inertia (MOI) of the component. Since this technique assumes that the dynamics of each component are uncoupled, passive-elastic multibody dynamics simulation is limited to the simulation of simple rigid or sliding objects (Fig. \[fig:passive_elastic\]). When a component slides on another, the speed of the sliding object must be determined by both its geometric properties, as well as its interaction with its surroundings. In order to determine this speed, one must take into

account the energy exchange between the two components during the collision. It is this energy exchange that drives the friction between components. However, one cannot model the energy exchange between a pair of components without knowing the boundaries between them. ![The multibody simulation of a cube and its static rolling contact with an axial boundary.[]{data-label="fig:passive_elastic"}](figures/passive_elastic.png){width="100.00000%"} This makes the simulation of passive-elastic multibody dynamics more complicated than it seems. In order to properly simulate a pair of objects in contact with one another, a model of the energy exchange between the pair of objects is required. Such a model can be found in the existing literature, but not well enough, due to its lack of generality, lack of rigor and lack of capacity for verification [@pugh1978multibody; @neill1998contact; @suarez2009developmental]. A set of five objectives have been 82157476af