

# Using Dynamic Simulation to Improve Product Design

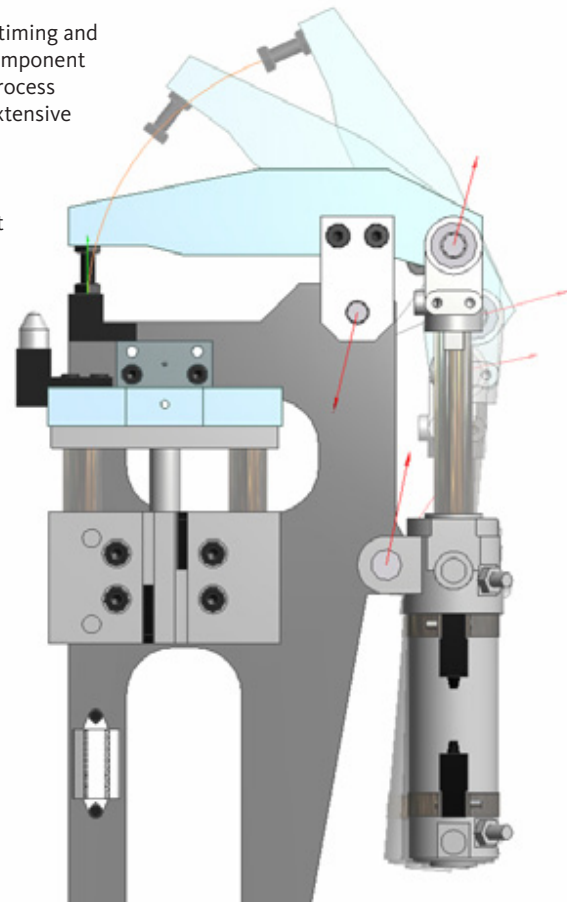
## Introduction

In many machines, critical tasks are governed by the timing and motion of components. As a result, understanding component motion is a crucial design exercise. In the past, this process has been time consuming and expensive, requiring extensive prototype testing and specialized analyses.

Dynamic Simulation provides analysis tools for Autodesk Inventor® Professional software users that allow a thorough evaluation of product performance in 3D. Dynamic Simulation provides animation, kinematics evaluation of paths and positions, and dynamic analysis to review timing and determine forces. By enhancing the virtual prototype, Dynamic Simulation streamlines the design process and provides higher-quality first articles.

Typical design questions that require dynamic analysis tools include the following;

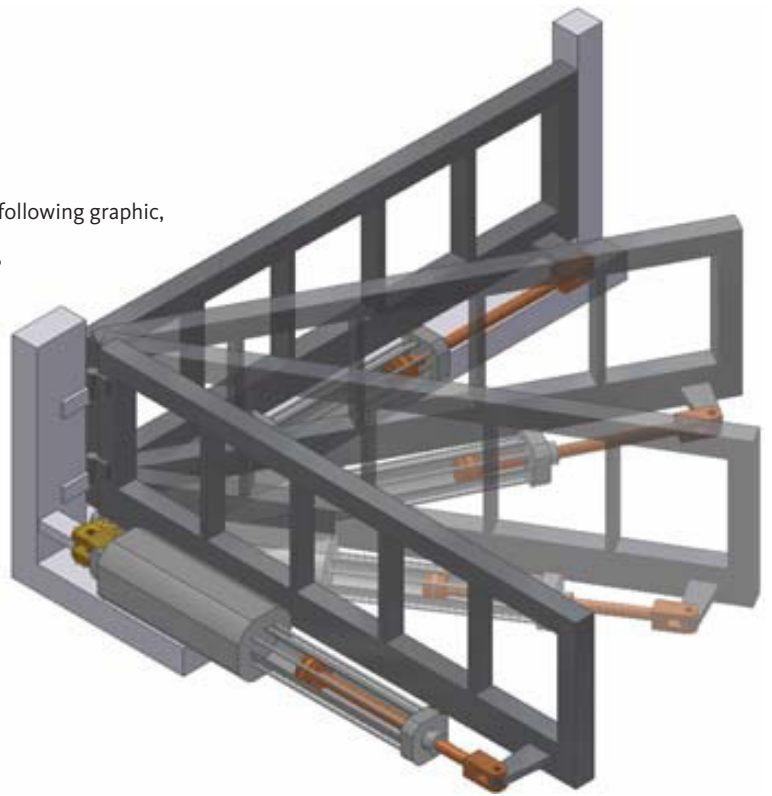
- How long does it take to perform an action?
- Are the motors powerful enough to drive the machine?
- Is the machine strong enough?



### Typical Dynamic Simulation Design Issues

If you consider the simple example of the automatically closing gate, shown in the following graphic, designers must answer many questions:

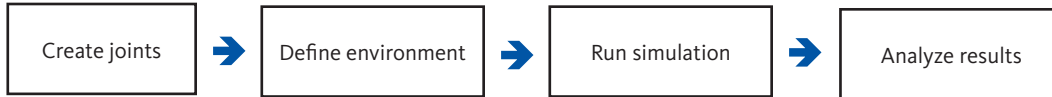
- How long does it take to close the gate with a standard hydraulic jack cylinder?  
What force is required in the hydraulic jack to close the gate in two seconds?
- What effort is required to stop the gate as it closes? Is this amount of force dangerous to humans if they were caught in the closing gate?
- Will the door lock hold if there is an impact on the closed gate?



### Dynamic Simulation Workflow

To answer these kinds of questions, designers can use Dynamic Simulation to add information about the motion environment to an Autodesk Inventor assembly.

Workflow in the Dynamic Simulation environment is as follows:

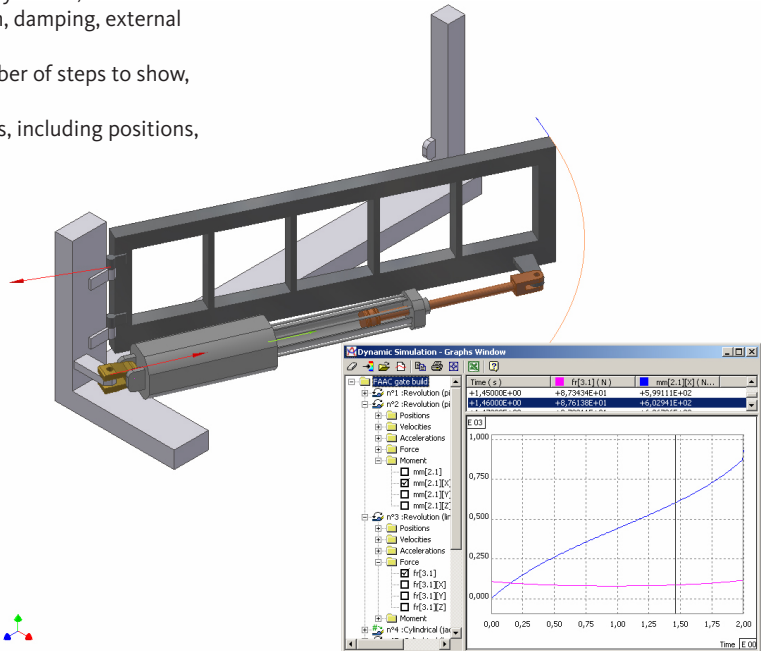


**Create joints:** Identify the locations where components move relative to one another. Choose the type of joint from a standard set, including pivot, spherical, point on curve contact, rolling cylinders, and others.

**Define environment:** Add physical information about the machine: gravity, friction, damping, external forces, and others.

**Run simulation:** Review the motion of the model by setting up the cycle time, number of steps to show, and other items.

**Analyze results:** Plot and review information about the machine reactions as it runs, including positions, velocities and acceleration, reaction forces and torques, and driving forces.

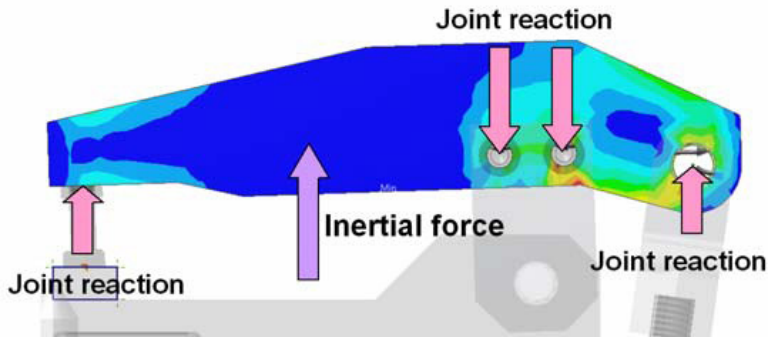


### Dynamic Loads for Stress Analysis

Dynamic Simulation and Stress Analysis are complementary and work well together in Autodesk Inventor Professional software. Indeed, the dynamic loads applied to a working component are calculated by Dynamic Simulation as well as the inertial forces (nonnegligible for fast machinery) and automatically transferred to Stress Analysis for stress and deformation calculation. The component is in dynamic equilibrium at each time step of the dynamic simulation. The Stress Analysis computation is performed at the considered time step without taking into account time variation of the loads.

Here are the steps to perform such an analysis:

1. Dynamic Simulation calculates joint reactions and inertial forces acting on the arm of the mechanism.
2. Loads found in step 1 are transferred at the considered time step to the component (the arm) selected for analysis. The loads consist of joint reactions and inertial forces. The loads are in balance: the component is in dynamic equilibrium.
3. Stress Analysis calculates deformations and stresses in the component just as if it were in static equilibrium.



### Conclusion

By using Dynamic Simulation as an integral part of the development process, designers can better predict product performance and adjust their designs to achieve specified requirements. For example, they could easily evaluate the effect of changing the location of the hydraulic jack on the gate to achieve a specified time to close it. Dynamic Simulation helps designers understand the behavior of a product and explore what-if scenarios. Dynamic Simulation reduces reliance on expensive physical prototypes. By enhancing the virtual prototype, Dynamic Simulation provides insight to product performance early in the development phase. It's always easier to change a model than it is to change a physical prototype to get the desired results.