MSC Software

Adams Machinery Gear Advanced 3D Contact

Simulating the Dynamics of High Fidelity Gears

SOLUTION BRIEF

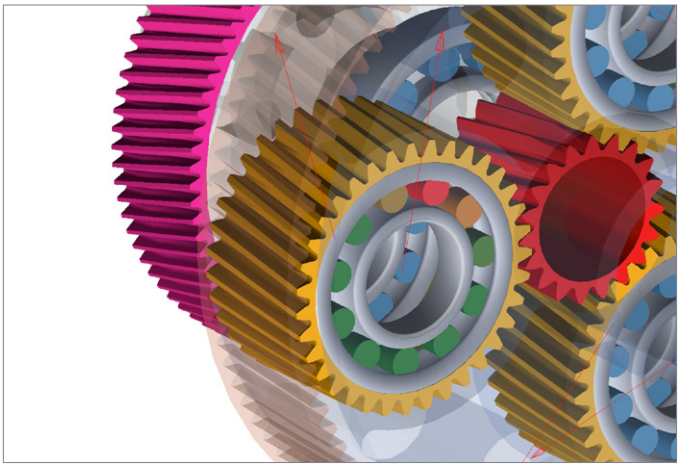
Field of Application

High performance gear systems are commonly required for modern vehicles and other machinery. For these systems market pressures on efficiency, noise and development timelines are requiring improved assessments of design performance before parts and test data become available.

Analysts are asked to predict system performance metrics for vibration, high-frequency excitation and transient dynamic behaviors based on design data alone. The Adams Machinery Gear Advanced 3D Contact tool provides additional capabilities suitable for these demands, including the incorporation of dynamic transmission error, tooth compliance and microgeometry – all leveraging a smooth and efficient contact methodology.

Traditional design procedures often do not account for system-level dynamic behaviors. Older methods typically rely on static design studies, although it is widely understood that these design procedures can't explain many of the failures seen in the field. Small, idealized component or subsystem dynamic models often fail to identify critical system-level behaviors, such as problematic meshing speeds due to coupled system modes.

The ability to easily incorporate detailed component models within an Adams system model facilitates much more accurate determination of both dynamic loads and system-level responses. The Advanced 3D Contact method is an extension of the Adams Machinery Gear module within the world leading multibody dynamics program Adams from MSC Software. This extension is within a user-friendly and efficient modeling and simulation process. It covers straight and helical internal and external cylindrical gears. It enables one to accurately evaluate gears from conceptual design through design studies and optimization.



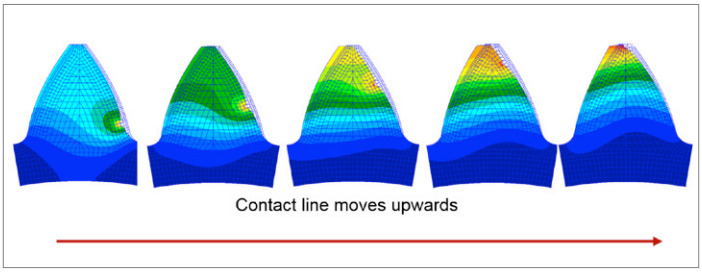
What is Advanced 3D Contact?

In previous releases, Adams Machinery Gears have been modeled as rigid parts with a separately defined compliance between gear pairs. In Adams 2017, with the Advanced 3D Contact method, we've introduced much more realistic gear tooth flexibility. This feature allows you to define the gear part geometry and material properties from which a finite element model (FEM) is created and solved in the background to define tooth compliance. No knowledge or installation of a Finite Element Analysis (FEA) tool is required since the meshing and FE-analysis are fully automated.

From the basis of these FEMs there are three options to define the contact behavior of the gear pair during the Adams analysis all of which represent the contact between gears in the Adams model as a six-component force:

- The Run Time option computes the contact behavior of the gears during the analysis and is the most accurate
- The Pre Computed option runs a setup analysis to predict contact behavior which saves time during the actual system simulation often with little trade-off in result accuracy
- The Rigid option simplifies things further by treating the gear teeth rigidly. This, however, is distinct from the pre-existing rigid-body 3D Contact method. The Advanced 3D Contact method's "Rigid" contact option frequently results in smoother forces because the contact detection is not based on traditional tessellation techniques but rather the FEM-based fine meshes. Also, there are more tooth and gear modification options available through the Advanced 3D Contact method including commonly applied micro-geometry modifications.

The flexible tooth options here provide superior accuracy compared to using an Adams Flex representation of the gears. Adams Flex uses the modal superposition method, which assumes that the part's deformation can be captured by superimposing normal mode shapes. But in the case of gears, most of the deformation takes places in the teeth themselves, which is difficult to capture in the mode shapes.



Capabilities

FE-mesh

- Straight or helical gears, internal or external gears
- Automated meshing
- User controls mesh density (lead and involute)

Contact algorithm

- No analytical stiffness assumption
- Smooth surface-to-surface contact
- Micro-geometry
- Coupled deformation of tooth (no slices)
- Friction, viscous and structural damping
- Tailored high performance algorithm
- Similar computational performance as rigid body contact

Results

- Resulting forces & torques
- Contact stress, friction power loss
- KH-beta, KF-beta, K-gamma
- Contact pattern, flank pressures
- Transmission error

About Adams

Adams is the world's most widely used Multibody Dynamics software. It's used by leading companies in multiple industries to develop and test the products we see everyday. Adams helps engineers to study the dynamics of moving parts, and how loads and forces are distributed throughout mechanical systems.

About MSC Software

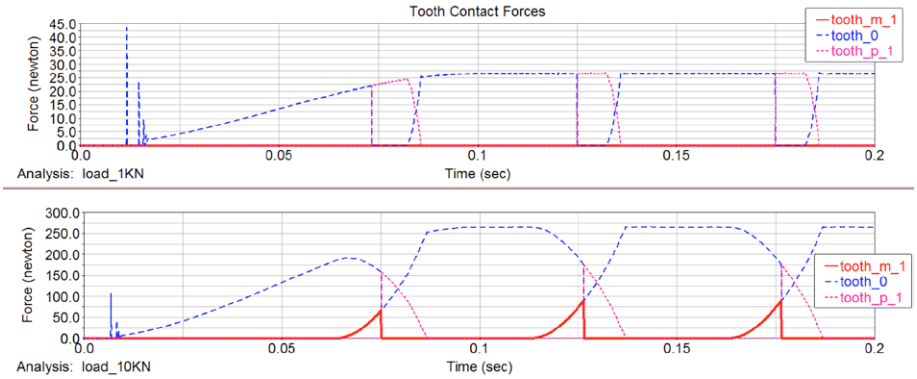
MSC Software is one of the ten original software companies and a global leader in helping product manufacturers to advance their engineering methods with simulation software and services.

www.mscsoftware.com

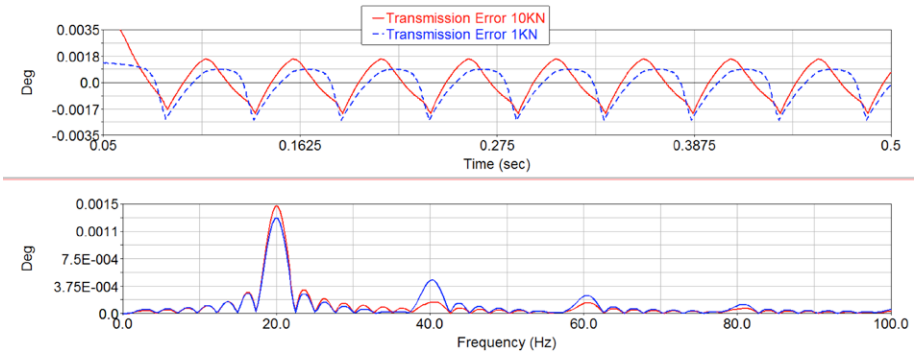
Why Use Advanced 3D Contact?

Advanced 3D Contact improves upon the preexisting Adams Machinery Gear methods in several ways ultimately allowing for the accurate calculation of dynamic gear meshing forces including microgeometry, tooth deformation and instantaneous misalignment. These capabilities allow users to evaluate meshing-order transmission error and system excitation, along with potential interactions of this behavior with case, shaft and bearing motions.

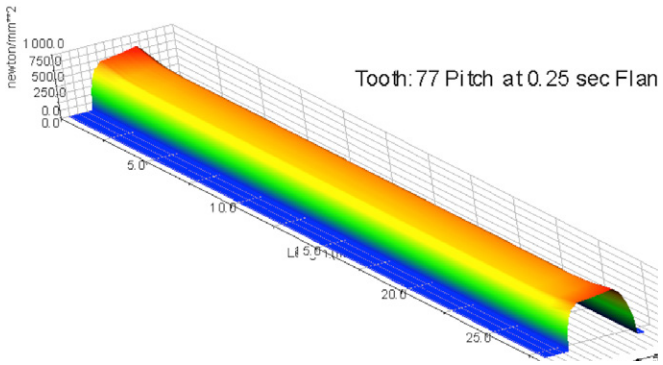
Users may evaluate the tooth contact pressures in high-load conditions and identify if the microgeometry used is sufficient for addressing potential stress concentrations. In addition, the enhanced tooth accuracy will provide improved dynamic predictions for rattle, whine and other transient operating conditions.



Tooth contact forces with different load conditions



Transmission errors with different load conditions



Micro-geometry -- Contact Pattern

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